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Distribution of Gammaridean Amphipoda (Crustacea) in the Middle Atlantic Bight Region

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John J. Dickinson, Roland L. Wigley,
Richard D. Brodeur, and Susan Brown-Leger

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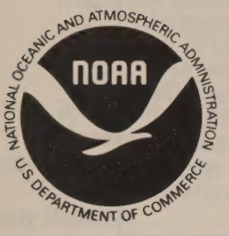

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U.S. DEPARTMENT OF COMMERCE
Philip M. Klutznick, Secretary
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Distribution of Gammaridean Amphipoda (Crustacea) in the Middle Atlantic Bight Region

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and SUSAN BROWN-LEGER[4]

ABSTRACT

The distribution and abundance of 101 species of marine benthic gammaridan amphipods are described for the Middle Atlantic Bight region. This report is based on 669 quantitative grab samples from 563 stations on the continental shelf and upper continental slope between Cape Cod, Mass., and Cape Hatteras, N.C. The amphipod fauna from the open shelf is most completely represented, but deep-sea and estuarine species are also included. The abundance of each species is reported in terms of its numerical density. Geographic and bathymetric distributions, and sediment relationships are also reported for each species.

INTRODUCTION

This report is based on collections of gammaridean amphipods from the Middle Atlantic Bight made by the Benthic Invertebrate Project at the Northeast Fisheries Center Laboratory of the National Marine Fisheries Service at Woods Hole, Mass. These collections were obtained as part of a reconnaissance of the entire Atlantic coastline designed to obtain an overview of the general composition and distribution of the macrobenthos (Wigley and Theroux In press).

Amphipods were not specifically sought in making these collections, but they were a major component in the macroinfaunal communities sampled. Gammaridean amphipods composed 40% of the number of specimens and 2% of the biomass of these Middle Atlantic Bight collections (Wigley and Theroux In press).

The importance of amphipods in the Northwest Atlantic has also been indicated by the results of food studies, which found that gammarideans were frequent prey items in the stomachs of over 40 species of fishes and were often the principal prey for the juvenile stages of several commercially important fishes (Bowman and Langton 1978).

The region between Cape Cod, Mass., and Cape Hatteras, N.C., is inhabited by about 150 species of gammaridean amphipods on the continental shelf (Bousfield 1973) with the likelihood of another 100 species occurring at bathyal and abyssal depths (Hessler and Sanders 1967). The continental shelf fauna is relatively well known with only a small number of new species to be described. The deepwater amphipod fauna of this area is poorly known with less than half the species presently described. Bousfield's (1973) excellent systematic monograph on the shallow-water amphipod fauna of New England includes most of the species encountered in the Middle Atlantic Bight, and it also provides a concise summary of the geographic range, bathymetric distribution, and sediment preference of each species. This reference served as the primary taxonomic source in identifying our gammarideans. Other useful taxonomic studies consulted were Sars (1895), Holmes (1905), Chevreux and Fage (1925), Shoemaker (1930a, b, 1945a, b), Stephensen (1935), Gurjanova (1951), Barnard (1960, 1969, 1971, 1972), Mills (1962, 1967b, 1971), Bousfield (1965), Barnard and Drummond (1976), Bynum and Fox (1977), and Laubitz (1977).

This report presents distributional data for 101 species of benthic gammaridean amphipods representing 55 genera in 17 families. The majority of the species (75%) are continental shelf forms, but both deep-sea (15%) and estuarine (10%) forms are also represented. Amphipod species characteristic of sand and mud are well represented in our collections, but species associated with rock and gravel bottoms are incompletely represented, reflecting the scarcity of hard substratum in the areas sampled.

In addition to the records of occurrence for all species, this report presents detailed breakdowns by latitude, depth, and sediment type of the numerical density estimates for the more abundant gammaridean species. The distributional data resulted in many extensions of both geographic and bathymetric ranges. In general, this report represents an addition to our knowledge of the distribution and abundance of the gammaridean amphipods of the Middle Atlantic Bight, particularly in the offshore areas of the coninental shelf.

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METHODS

The collections upon which this study were based consisted of over 70,000 amphipods from 669 quantitative grab samples from 563 stations between Cape Cod, Mass., and Cape Hatteras, N.C. (Fig. 1). The basic pattern of stations was a sampling grid with stations spaced 18 km apart, but there were many additional stations particularly in the northern portion of the study area. The grid pattern resulted in a predominance of samples in the open shelf habitat, because of its substantially greater area, with fewer stations being taken in estuarine and deep-sea habitats. Station data including latitude, longitude, date, gear type, depth, and sediment type are listed in Wigley et al. (1976[5]). The general patterns of bathymetry and sediment distribution are shown in Figures 2 and 3.

Wigley and Theroux (In press) subdivided the Middle Atlantic Bight into three subareas: Southern New England, the New York Bight, and the Chesapeake Bight (Fig. 2). These subareas are useful in making geographic comparisons and will be followed in this paper.

Collections were made with three different sized grabs: the Campbell grab (0.56 m^2), the Smith-McIntyre grab (0.1 m^2), and the Van Veen grab (0.2 m^2). The Campbell grab was used at 355 stations, the Smith-McIntyre at 195 stations, and the Van Veen at 13 stations. Each sample provided material for both biological and geological analyses.

The methods of shipboard sample processing are described in detail by Wigley and Theroux (In press). All grab samples were washed over a 1 mm mesh sieve and preserved in buffered Formalin. In the laboratory, the amphipods were sorted out of the samples along with other major taxa, transferred to ethanol, identified, and enumerated using dissecting microscopes. The species counts were adjusted to a per m^2 basis taking into account the sampler size and any subsamples removed. The density data for each species were correlated with depth, sediment type, and latitude in an effort to elucidate major patterns of abundance.

SYSTEMATIC ARRANGEMENT

The systematic arrangement and terminology follow Barnard (1960, 1969, 1972, 1973) at the genus and family levels. Bousfield's (1977) recent work on gammaridean systematics was consulted, but we chose to follow Barnard (1969) in order to maintain a consistent hierarchical arrangement. The species names are primarily as in Bousfield (1973). The list of species in their respective families is as follows:

Order AMPHIPODA
Suborder GAMMARIDEA

Family AMPELISCIDAE
Ampelisca abdita Mills 1964
Ampelisca agassizi (Judd) 1896
Ampelisca declivitatis Mills 1967
Ampelisca macrocephala Liljeborg 1852
Ampelisca uncinata Chevreux 1887
Ampelisca vadorum Mills 1963
Ampelisca verrilli Mills 1967
Byblis gaimardi Krøyer 1846
Byblis serrata Smith 1873
Haploops similis Stephenson 1925

Family ARGISSIDAE
Argissa hamatipes (Norman) 1869

Family BATEIDAE
Batea catharinensis Müller 1865

Family CALLIOPIIDAE
Calliopius laeviusculus (Krøyer) 1838

Family COROPHIIDAE
Corophium acutum Chevreux 1908
Corophium crassicorne Bruzelius 1859
Corophium tuberculatum Shoemaker 1934
Gammaropsis maculatus (Johnston) 1827
Gammaropsis nitida (Stimpson) 1853
Lembos smithi Holmes 1905
Lembos websteri Bate 1856
Leptocheirus pinguis (Stimpson) 1853
Leptocheirus plumolosus Shoemaker 1932
Microprotopus raneyi Wigley 1966
Neohela monstrosa (Boeck) 1861
Photis dentata Shoemaker 1945
Photis macrocoxa Shoemaker 1945
Protomedeia fasciata Krøyer 1842
Pseudunciola obliquua (Shoemaker) 1949
Rildardanus laminosa (Pearse) 1912
Siphonoecetes smithianus Rathbun 1908
Unciola inermis Shoemaker 1945
Unciola irrorata Say 1818
Unciola laticornis Hansen 1887
Unciola leucopis (Krøyer) 1845
Unciola serrata Shoemaker 1945
Unciola spicata Shoemaker 1945
Unciola sp. A
Unciola sp. B

Family EUSIRIDAE
Pontogeneia inermis (Krøyer) 1838
Rhachotropis inflata (G. O. Sars) 1882

Family GAMMARIDAE
Casco bigelowi (Blake) 1929
Elasmopus levis Smith 1873
Eriopisa elongata (Bruzelius) 1859
Gammarus annulatus Smith 1873
Gammarus daiberi Bousfield 1969
Gammarus mucronatus Say 1818
Gammarus tigrinus Sexton 1939
Maera danae Stimpson 1853
Melita dentata (Krøyer) 1842
Melita nitida Smith 1873
Melita sp. A

[5]Wigley, R. L., R. B. Theroux, and H. E. Murray. 1976. Macrobenthic invertebrate fauna of the Middle Atlantic Bight Region. Part I. Collection data and environmental muasurements. Northeast Fish. Cent. Rep., Woods Hole, Mass., 34 p.

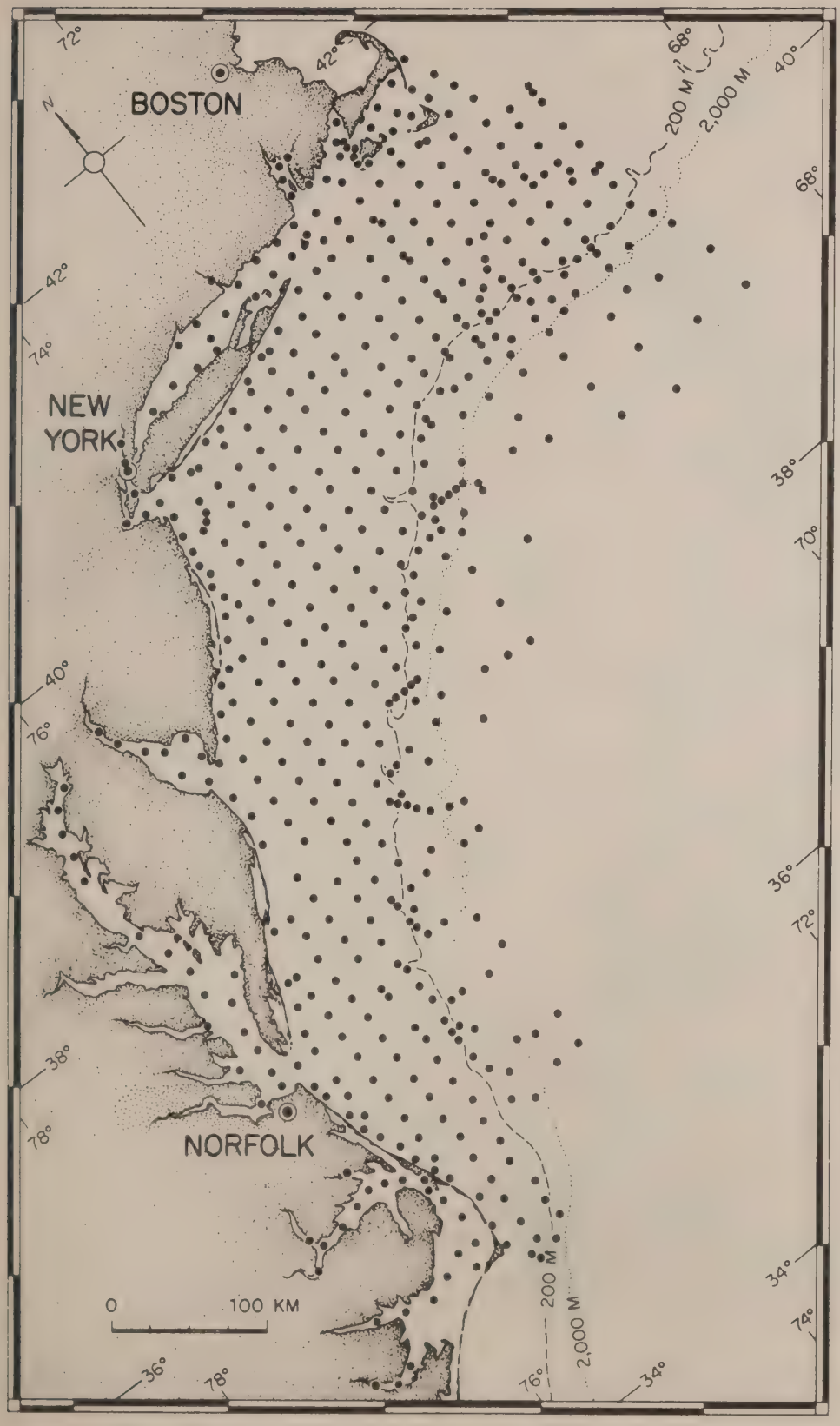

Figure 1.—Station location in the Middle Atlantic Bight where quantitative grab samples were collected. (After Wigley and Theroux 1979.)

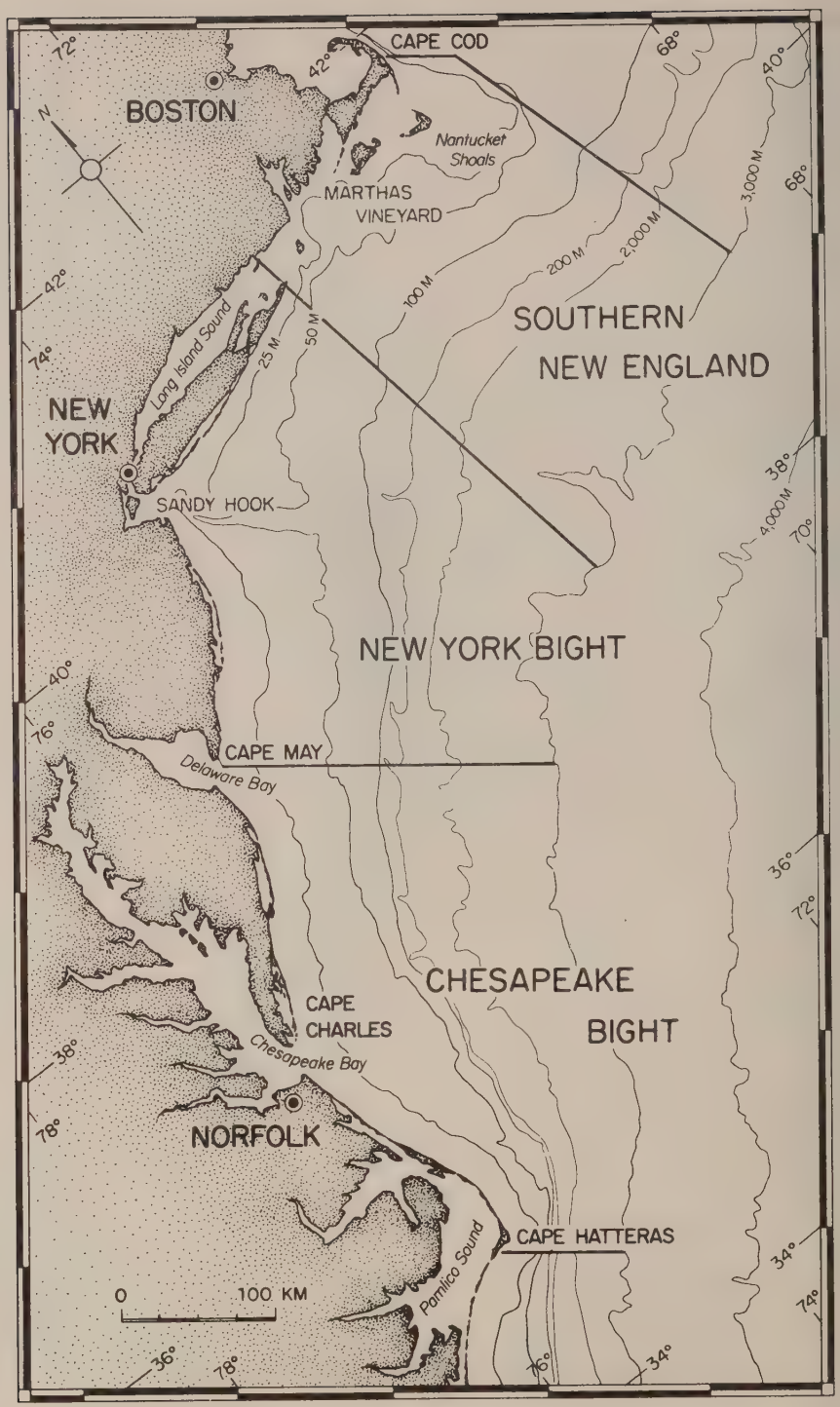

Figure 2.—Geographical features of the Middle Atlantic Bight Region and the three subarea divisions: Southern New England, New York Bight, and Chesapeake Bight. (Modified from Wigley and Theroux 1979.)

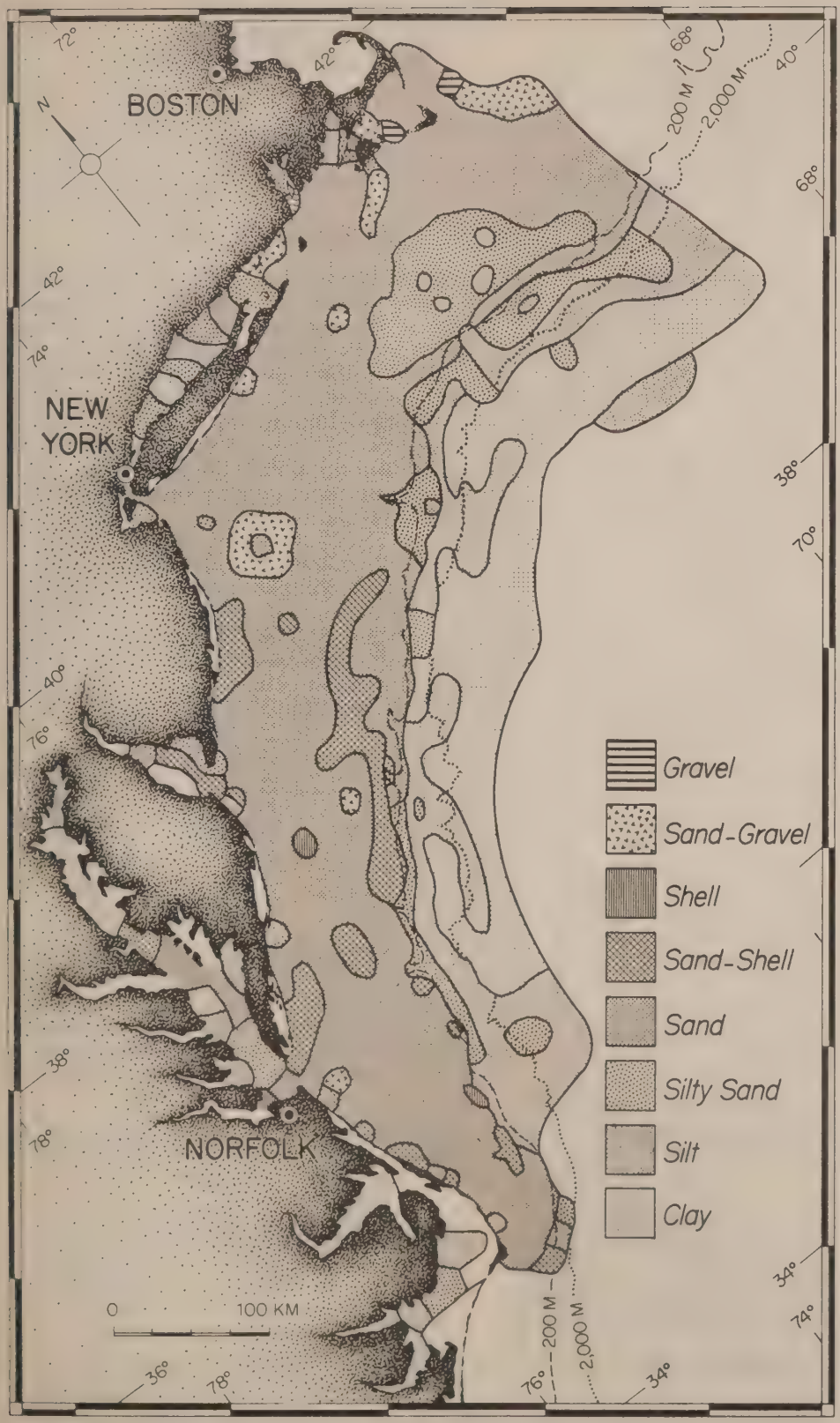

Figure 3.—Geographic distribution of bottom sediment types in the Middle Atlantic Bight. (After Wigley and Theroux 1979.)

Family HAUSTORIIDAE
Subfamily PONTOPOREIINAE
Amphiporeia gigantea Bousfield 1973
Bathyporeia parkeri Bousfield 1973
Bathyporeia quoddyensis Shoemaker 1949
Subfamily HAUSTORIINAE
Acanthohaustorius intermedius Bousfield 1965
Acanthohaustorius spinosus Bousfield 1962
Acanthohaustorius sp. A
Acanthohaustorius sp. B
Acanthohaustorius sp. C
Parahaustorius attenautus Bousfield 1965
Parahaustorius holmesi Bousfield 1965
Protohaustorius deichmannae Bousfield 1965
Protohaustorius wigleyi Bousfield 1965
Pseudohaustorius borealis Bousfield 1965
Family ISCHYROCERIDAE
Cerapus tubularis Say 1818
Ericthonius brasiliensis (Dana) 1853
Ericthonius rubricornis Smith 1873
Ischyrocerus anguipes Krøyer 1838
Jassa falcata (Montagu) 1818
Family LILJEBORGIIDAE
Idunella sp. A
Liljeborgia sp. A
Listriella barnardi Wigley 1966
Family LYSIANASSIDAE
Anonyx liljeborgi Boeck 1871
Anonyx sarsi Steele and Brunel 1968
Cheirimedon sp. A
Hippomedon propinquus G. O. Sars 1895
Hippomedon serratus Holmes 1905
Hippomedon sp. A
Hippomedon sp. B
Hippomedon sp. C
Lysianopsis alba Holmes 1905
Orchomene minuta (Krøyer) 1846
Orchomene pectinata G. O. Sars 1895
Psammonyx nobilis (Stimpson) 1853
Tmetonyx cicada (O. Fabricius) 1780
Family OEDICEROTIDAE
Monoculodes edwardsi Holmes 1905
Synchelidium americanum Bousfield 1973
Family PHOXOCEPHALIDAE
Harpinia abyssi G. O. Sars 1885
Harpinia antennaria Meinert 1893
Harpinia propinqua G. O. Sars 1895
Harpinia truncata G. O. Sars 1895
Harpinia sp. A
Harpiniopsis sp. A
Paraphoxus epistomus (Shoemaker) 1938
Phoxocephalus holbolli (Krøyer) 1842
Family PLEUSTIDAE
Stenopleustes gracilis (Holmes) 1905
Stenopleustes inermis Shoemaker 1949
Family PODOCERIDAE
Dyopedos monacantha (Metzger) 1875
Family STENOTHOIDAE
Metopella angusta Shoemaker 1949
Family SYNOPIIDAE
Syrrhoe crenulata Göes 1866
Tiron tropakis J. L. Barnard 1972

SPECIES ACCOUNTS

Family AMPELISCIDAE

Ampelisca abdita Mills 1964

Geographic Distribution. This species has been reported from shallow protected waters along the coast of eastern North America from the Bay of Fundy to Florida and in the eastern Gulf of Mexico (Mills 1964; Bousfield 1973; Wildish and Wilson 1976[6]). We collected *A. abdita* at 27 stations in protected waters between Massachusetts and Virginia (Fig. 4). This abundant estuarine species had a mean density of 420/m², ranging between 7/m² and 3,800/m². The density of *A. abdita* showed no evidence of changing along the latitudinal gradient within our study area.

Bathymetric Distribution. *Ampelisca abdita* has been collected between 0 and 60 m (Bousfield 1973). In our collections from the Middle Atlantic Bight region, it occurred between 4 and 30 m with the highest mean density (630/m²), occurring between 10 and 19 m (Table 1). There was no change in the bathymetric distribution of this species with latitude.

Table 1.—Bathymetric distribution of *Ampelisca abidita* in samples from the Middle Atlantic Bight.

Depth interval (m)	Number of samples	Mean density (No./m²)
0-9	7	190
10-19	11	630
20-29	8	380
30-39	1	60

Sediment Relationship. According to Mills (1964, 1967a), *A. abdita* occurs most frequently on silty sand bottoms. We collected this species on sediments ranging from shell to silt-clay, but the highest mean densities (540/m²) and largest numbers of samples occurred on sand (6/27) and sand-silt (14/27) bottoms (Table 2).

[6]Wildfish, D. J., and A. C. Wilson. 1976. Check list for sublittoral macro-infauna sampled between 1970 and 1975 in four Bay of Fundy estuaries. Fish. Res. Board Can. MS Rep. (Biol.), 1398, 12 p.

Table 2.—Sediment associations of *Ampelisca abdita* in samples from Middle Atlantic Bight.

Sediment type	Number of samples	Mean density (No./m²)
Sand-gravel	0	—
Shell	1	100
Sand-shell	1	10
Sand	6	540
Sand-silt	14	540
Silt-clay	5	110

Figure 4.—Geographic distribution of species from the family Ampeliscidae in the Middle Atlantic Bight.

Ampelisca agassizi (Judd) 1896

Geographic Distribution. This species has been reported from both the Atlantic and Pacific coasts of North America (Barnard 1971; Mills 1971). Bousfield (1973) reported that this species is distributed from Nova Scotia to the Caribbean along the eastern coast of North America. In our collections from the Middle Atlantic Bight region, *A. agassizi* occurred in 161 samples from 125 stations between Massachusetts and North Carolina (Fig. 4). This was the most abundant species in our study area with a mean density of 910/m², ranging between 2/m² and 15,000/m². *Ampelisca agassizi* showed a clear trend of decreasing abundance from north to south with mean densities decreasing from 1,200/m² in southern New England to 290/m² in the New York Bight and 75/m² in the Chesapeake Bight.

Bathymetric Distribution. Mills (1971) gave a depth range for *A. agassizi* as 5-450 m. We collected *A. agassizi* between 22 and 450 m. The highest densities (1,500-3,000/m²) occurred between 70 and 99 m, and 70% of the samples were collected between 40 and 99 m (Table 3). South of Cape May, N.J., *A. agassizi* was found only in the deeper (73-400 m) and colder waters of the outer continental shelf and upper continental slope. This pattern of "southern submergence" is usually interpreted as an avoidance response by the species to the higher temperatures found in southern inshore waters (Ekman 1953).

Sediment Relationship. Bousfield (1973) reported that *A. agassizi* is most often collected from stable coarse sands. We collected this species on sediments ranging from sand-gravel to silt-clay (Table 4), but the highest mean densities (1,300/m²) and the largest number of samples were found on sand bottoms.

Table 3.—Bathymetric distribution of *Ampelisca agassizi* in samples from Middle Atlantic Bight.

Depth interval (m)	Number of samples	Mean density (No./m²)
20-29	2	3
30-39	10	170
40-49	19	340
50-59	21	340
60-69	17	720
70-79	22	3,000
80-89	17	1,600
90-99	15	1,500
100-124	10	30
125-149	6	40
150-199	10	60
200-299	6	120
300-499	6	4

Table 4.—Sediment associations of *Ampelisca agassizi* in samples from Middle Atlantic Bight.

Sediment type	Number of samples	Mean density (No./m²)
Sand-gravel	2	20
Shell	3	30
Sand-shell	3	40
Sand	105	1,300
Sand-silt	42	220
Silt-clay	6	190

Ampelisca declivitatis Mills 1967

Mills (1967b, 1971) reported that *A. declivitatis* has been recorded from western Greenland south to the Middle Atlantic States between 100 and 1,100 m with maximum abundance around 400 m. Our collections from the Middle Atlantic Bight consisted of a few specimens from each of seven stations in upper bathyal waters (440-580 m) between Long Island and Cape Hatteras (Fig. 4). Bottom types at these seven stations included sand (3/7), sand-silt (3/7), and silt (1/7). The abundance of *A. declivitatis* was uniformly low at all stations with a mean density of 4/m², ranging between 2/m² and 11/m².

Ampelisca macrocephala Liljeborg 1852

Geographic Distribution. This cosmopolitan species has been collected from Norway to Alaska in the North Atlantic and Arctic Oceans, and from Washington to California in the North Pacific Ocean (Barnard 1971; Mills 1967b). Bousfield (1973) reported that this species has been recorded from Greenland south to Rhode Island along the North American coast. We collected *A. macrocephala* in 31 samples at 23 stations between Cape Cod and central New Jersey (Fig. 4). The three stations south of Long Island and the single station east of New Jersey extend the known geographic range of this species along the east coast of North America. This species was moderately abundant in our study area with a mean density of 80/m², ranging from 2/m² to 400/m². The highest densities of this arctic boreal species were found at the more northerly stations, which is to be expected since species normally decrease in abundance as they approach the limits of their geographic range.

Bathymetric Distribution. The bathymetric range of *A. macrocephala* is from 10 to 280 m (Mills 1971). We collected this species between 34 and 73 m. The bulk of the samples (24/31) occurred between 30 and 59 m, but the highest densities occurred at the stations >60 m (Table 5).

Table 5.—Bathymetric distribution of *Ampelisca macrocephala* in samples from Middle Atlantic Bight.

Depth interval (m)	Number of samples	Mean density (No./m²)
30-39	5	20
40-49	12	60
50-59	7	60
60-69	5	160
70-79	2	180

Sediment Relationship. Bousfield (1973) reported that *A. macrocephala* is usually found on stable sandy bot-

toms. All 31 samples from the Middle Atlantic Bight were taken from sand bottoms.

Ampelisca uncinata Chevreux 1887

Mills (1971) reported the occurrence of *A. uncinata* on the continental slope south of Cape Cod between 460 and 1,100 m. He suggested that this species may be widespread in the North Altantic at bathyal depths (350-1,100 m). *Ampelisca uncinata* occurred in our collections at two stations on the continental slope south of Cape Cod and Long Island (Fig. 5). Both of these stations were on sand bottoms at a depth of 450 m. The density of this species was low at both stations (3-7/m²).

Ampelisca vadorum Mills 1962

Geographic Distribution. Mills (1964) reported that this species is distributed from the Gulf of St. Lawrence to the Gulf of Mexico. We collected *A. vadorum* in 76 samples from 74 stations from Cape Cod to Cape Hatteras (Fig. 5). This species was moderately abundant with a mean density of 70/m², ranging from 2/m² to 1,900/m². There was no evidence for a latitudinal trend in the abundance of this species within the area sampled, but it is worth noting that *A. vadorum* occurred much less frequently in the New York Bight area.

Mills (1963, 1964) indicated that *A. vadorum* occurred principally in the protected waters of bays and estuaries like its sibling species *A. abdita*. However, we collected *A. vadorum* much more frequently in the open waters of the continental shelf than in protected waters.

Bathymetric Distribution. Ampelisca vadorum has been recorded from low intertidal down to 70 m (Bousfield 1973). In our samples, this species occurred between 8 and 104 m. Although it was relatively common between 10 and 70 m, the highest mean densities (130-190/m²) occurred between 10 and 29 m (Table 6). The bathymetric distribution of *A. vadorum* did not change along the latitudinal gradient within our study area.

Table 6.—Bathymetric distribution of *Ampelisca vadorum* in samples from Middle Atlantic Bight.

Depth interval (m)	Number of samples	Mean density (No./m²)
0-9	1	70
10-19	8	130
20-29	16	190
30-39	14	10
40-49	13	30
50-59	8	20
60-69	8	50
70-79	5	20
80-89	2	5
90-99	0	—
100-124	1	4

Sediment Relationship. According to Bousfield (1973), *A. vadorum* is most commonly found in medium to coarse sands and shelly sands. We collected *A. vadorum* on sediments ranging from sand-gravel to sand-silt (Table 7). The majority of the samples (54/76) and the highest mean density (90/m²) occurred on sand bottoms.

Table 7.—Sediment associations of *Ampelisca vadorum* in samples from Middle Atlantic Bight.

Sediment type	Number of samples	Mean density (No./m²)
Sand-gravel	6	70
Shell	3	8
Sand-shell	8	20
Sand	54	90
Sand-silt	5	20
Silt-clay	0	—

Ampelisca verrilli Mills 1967

Geographic Distribution. This species has been reported from shallow coastal waters off eastern North America from Cape Cod to Cape Hatteras (Mills 1967b). We collected *A. verrilli* at 33 stations between Massachusetts and North Carolina (Fig. 5). This species occurred in both the protected waters of bays and estuaries, and along the open coast. This was an abundant species at the stations where it occurred with a mean density of 250/m², ranging between 2/m² and 2,700/m². There was no evidence for a latitudinal trend in the density of this species.

Bathymetric Distribution. Bousfield (1973) gave the depth range of *A. verrilli* as 0-50 m. We collected this species between 4 and 37 m. The highest mean density (410/m²) and 55% of the samples occurred between 10 and 19 m (Table 8). This temperate water species did not change its bathymetric distribution within the latitudinal gradient of our study area.

Table 8.—Bathymetric distribution of *Ampelisca verrilli* in samples from Middle Atlantic Bight.

Depth interval (m)	Number of samples	Mean density (No./m²)
0-9	5	40
10-19	18	410
20-29	9	40
30-39	1	9

Sediment Relationship. Mills (1967b) found that *A. verrilli* occurred most frequently on coarse sands. We collected *A. verrilli* on sediments ranging from shell to silty sand (Table 9). This species occurred most frequently on sand bottoms (22/33), but its mean density was also high (240-370/m²) on shell and sand-shell sediments.

Byblis gaimardi Krøyer 1846

Mills (1971) reported that this circumpolar species occurs throughout the North Atlantic and Arctic Oceans from Iceland to Alaska. In the western Atlantic, this

Figure 5.—Geographic distribution of species from the family Ampeliscidae in the Middle Atlantic Bight.

Table 9.—Sediment associations of *Ampelisca verrilli* in samples from Middle Atlantic Bight.

Sediment type	Number of samples	Mean density (No./m²)
Sand-gravel	0	—
Shell	2	370
Sand-shell	6	240
Sand	22	260
Sand-silt	3	60
Silt-clay	0	—

species has been reported from Greenland south to Cape Cod between 5 and 575 m (Mills 1971). We collected a single specimen of *B. gaimardi* along the northernmost transect of our study area (Fig. 5). This station was at 185 m depth on a sand bottom. The absence of further records to the south supports Mills' (1971) description of the geographic range of this species.

Byblis serrata Smith 1873

Geographic Distribution. This species has been reported from the south side of Cape Cod to Chesapeake Bay (Mills 1971). In our Middle Atlantic Bight collections, *B. serrata* occurred in 145 samples from 130 stations between Cape Cod and Cape Hatteras (Fig. 5). This species was relatively abundant in our samples with a mean density of 290/m², ranging between 2/m² and 9,200/m². There was no evidence of a latitudinal trend in the density of this species.

Bathymetric Distribution. According to Mills (1971), *B. serrata* occurs from intertidal depths to 200 m. We collected *B. serrata* between 10 and 201 m. The majority of the samples (116/145) occurred between 20 and 69 m with the highest mean density (1,400/m²), occurring between 20 and 29 m (Table 10). It is worth noting that this species is absent from waters shallower than 40 m off southern New Jersey and Maryland, but it is commonly found in water as shallow as 15 m off Virginia and North Carolina. This distribution pattern cannot be explained with presently available environmental data, but other species (i.e., *Leptocheirus pinguis*) show a similar pattern.

Table 10.—Bathymetric distribution of *Byblis serrata* in samples from Middle Atlantic Bight.

Depth interval (m)	Number of samples	Mean density (No./m²)
10-19	9	220
20-29	16	1,400
30-39	30	180
40-49	33	290
50-59	21	120
60-69	16	10
70-79	6	30
80-89	7	7
90-99	2	9
100-124	2	6
125-149	1	2
150-199	1	20
200-299	1	10

Sediment Relationship. *Byblis serrata* occurs most frequently on medium to coarse sand bottoms (Bousfield 1973). We collected *B. serrata* on sediment types ranging from sand-gravel to sand-silt, but it occurred most frequently (117/145), and in the highest densities (350/m²), on sand bottoms (Table 11).

Table 11.—Sediment associations of *Byblis serrata* in samples from the Middle Atlantic Bight.

Sediment type	Number of samples	Mean density (No./m²)
Sand-gravel	8	80
Shell	4	20
Sand-shell	12	60
Sand	117	350
Sand-silt	4	20
Silt-clay	0	—

Haploops similis Stephensen 1925

Mills (1971) found this species south of Cape Cod on the continental slope between 800 and 2,900 m. He suggested that this species may be widespread in the North Atlantic at bathyal depths although it has been reported only from a few scattered localities. We collected *H. similis* at six stations from the continental slope and rise between lat. 38°N and 40°N (Fig. 5). The stations were located between 491 and 2,840 m on silt (4/6), silty sand (1/6), and clay (1/6) bottoms. The density of this species was uniformly low (2-4/m²).

Family ARGISSIDAE

Argissa hamatipes (Norman) 1869

This widely distributed species occurs throughout the subarctic regions of both the Atlantic and Pacific Oceans (Barnard 1971; Bousfield 1973). In the western Atlantic, *A. hamatipes* has been reported from Labrador south to North Carolina between 5 and 100 m on sand and gravel sediments (Bousfield 1973; Fox and Bynum 1975). This species occurred at seven of our stations just south of Martha's Vineyard (Fig. 6). These records came from between 38 and 73 m on sand (4/7) and silty sand (3/7) bottoms. The density of this species was low (10-20/m²) at all seven stations.

Family BATEIDAE

Batea catharinensis Müller 1865

Bousfield (1973) reported that this warm temperate species may be found from the south side of Cape Cod to Florida and the Gulf of Mexico. This species is found subtidally to 20 m on stony and gravelly bottoms. We collected *B. catharinensis* at two stations in Buzzards Bay at 10 and 18 m on sand and silty sand bottoms (Fig. 6). The density of the species was low at both stations (10-16/m²). The scarcity of *B. catharinensis* in our col-

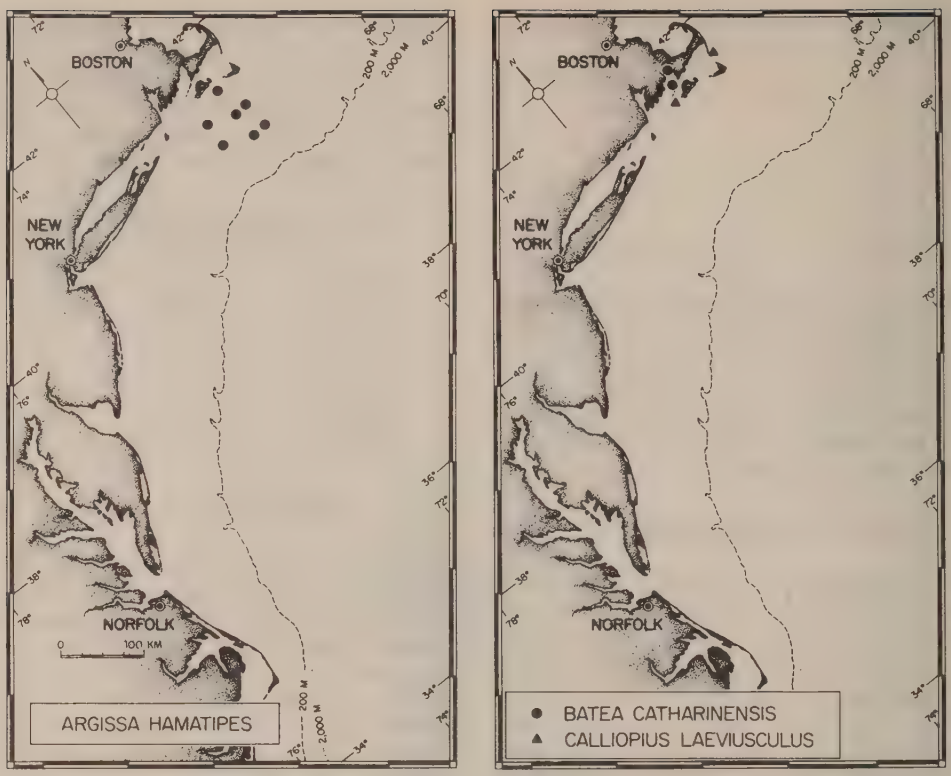

Figure 6.—Geographic distribution of species from the families Argissidae, Bateidae, and Calliopiidae in the Middle Atlantic Bight.

lections is probably the result of its preference for rocky bottoms, which we were unable to sample with our gear.

Family CALLIOPIIDAE

Calliopius laeviusculus (Krøyer) 1838

This widely distributed species is found throughout the arctic and subarctic regions of the Atlantic and Pacific Oceans, and occurs from Labrador south to New Jersey along the east coast of North America (Bousfield 1973). *Calliopius laeviusculus* occurred in low densities (2-19/m²) at two stations south of Cape Cod in 18 and 33 m on sand bottoms (Fig. 6). According to Steele and Steele (1973), *C. laeviusculus* is usually found clinging to algae on rocky shores, but it also swarms in the plankton during the summer. Its habitat preference for rocky shores explains its scarcity in our collections.

Family COROPHIIDAE

Corophium acutum Chevreux 1908

This species is nearly cosmopolitan in warm temperate regions and is found from Florida north to Cape Cod along the eastern coast of North America (Bousfield 1973). In our collections, *C. acutum* occurred at two stations in the upper Chesapeake Bay in shallow water (7-16 m) on mud bottoms (Fig. 7).

Corophium crassicorne Bruzelius 1859

Geographic Distribution. This species is distributed throughout the arctic-boreal regions of the North Atlantic and Northeast Pacific, and has previously been taken as far south as Long Island Sound along the east coast of North America (Lie 1968; Bousfield 1973). We collected *C. crassicorne* in 96 samples from 84 stations between Cape Cod and the mouth of Chesapeake Bay (Fig. 7). The 47 records south of Long Island extend the range of this species to Virginia. This species was rather abundant with a mean density of 110/m², ranging between 2/m² and 3,200/m². *Corophium crassicorne* shows a clear pattern of decreasing abundance from north to south with the mean density going from 200/m² in southern New England to 40/m² in the New York Bight to 9/m² in the Chesapeake Bight.

Bathymetric Distribution. Bousfield (1973) reported that this species may be found subtidally to 200 m. In our samples, *C. crassicorne* occurred between 15 and 77 m with the largest concentration of samples (54/95), oc-

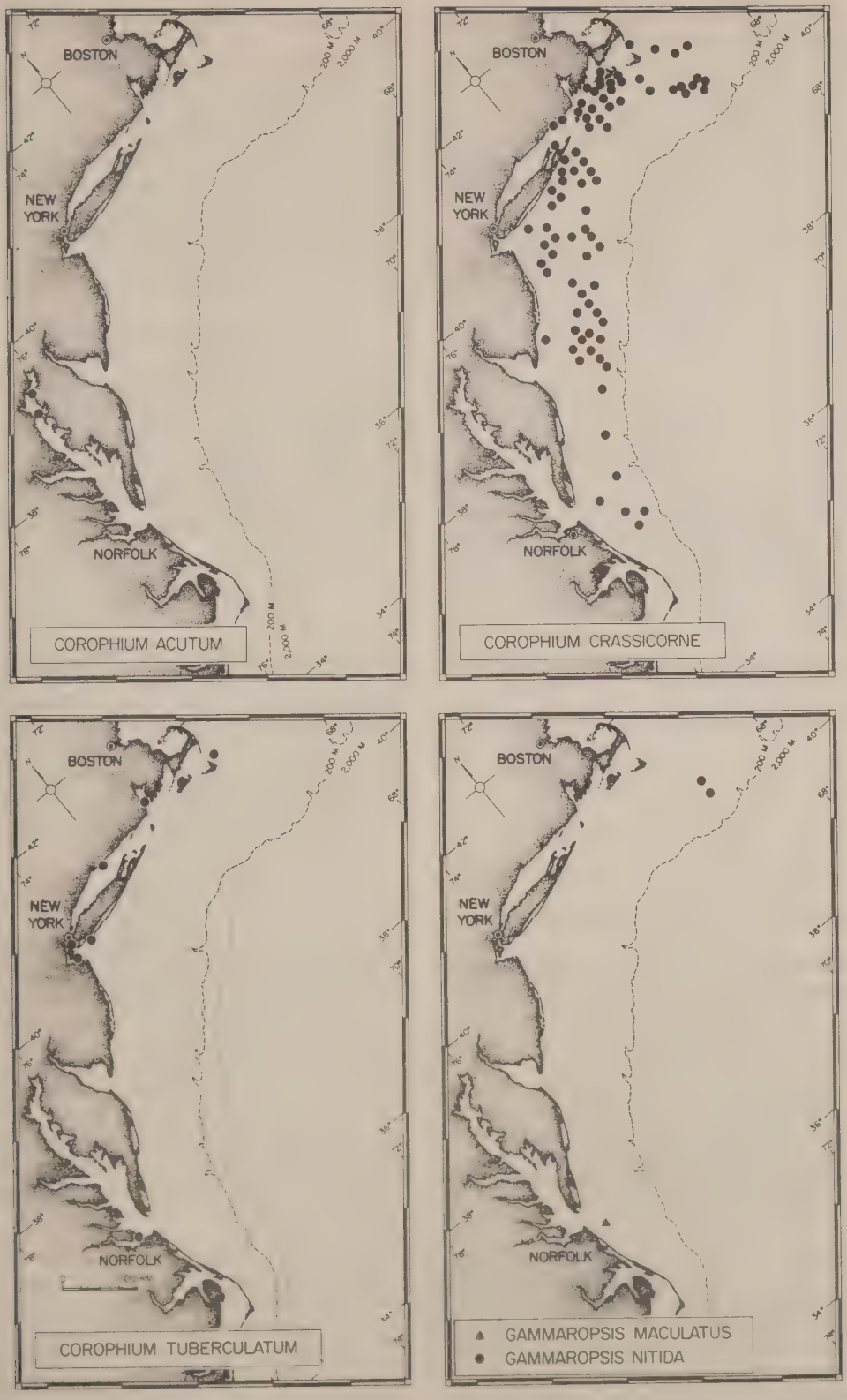

Figure 7.—Geographic distribution of species from the family Corophiidae in the Middle Atlantic Bight.

curring between 30 and 49 m (Table 12). The highest mean density (400/m²) occurred between 20 and 29 m. This species occurred much less frequently in shallow water in the southern portion of our study area. Only one of the 33 stations south of Sandy Hook was in <30 m, whereas 12 of the 50 stations north of Sandy Hook were in <30 m. This trend indicates that *C. crassicorne* has a tendency for southern submergence.

Table 12.—Bathymetric distribution of *Corophium crassicorne* in samples from Middle Atlantic Bight.

Depth interval (m)	Number of samples	Mean density (No./m²)
10-19	4	140
20-29	9	400
30-39	27	80
40-49	27	110
50-59	14	70
60-69	10	30
70-79	4	30

Sediment Relationship. Bousfield (1973) stated that *C. crassicorne* is usually found on consolidated sandy bottoms. In our collections, this species occurred on sediments ranging from gravel to silty sand, but it was most common (79/96) on sand bottoms (Table 13).

Table 13.—Sediment associations of *Corophium crassicorne* in samples from Middle Atlantic Bight.

Sediment type	Number of samples	Mean density (No./m²)
Sand-gravel	9	150
Shell	0	—
Sand-shell	6	30
Sand	79	120
Sand-silt	2	5
Silt-clay	0	—

Corophium tuberculatum Shoemaker 1934

This tube-dwelling amphipod has been reported from bays and estuaries between the Bay of Fundy and the Gulf of Mexico (Bousfield 1973). In our collections, *C. tuberculatum* occurred at seven stations in coastal and protected waters from Nantucket, Mass., to Chesapeake Bay (Fig. 7). All of these stations were in shallow water (8-16 m), but a wide variety of sediment types was represented including gravelly shell, shell, sand, sand-silt-clay, shelly silt-clay, and clayey silt. This species was moderately abundant with a mean density of 50/m², ranging between 10/m² and 150/m².

Gammaropsis maculatus (Johnston) 1827

According to Bousfield (1973), this species is amphi-Atlantic in the boreal regions, and it is known to occur south to North Carolina in the northwestern Atlantic (Fox and Bynum 1975). *Gammaropsis maculatus* occurred at a single station off Norfolk, Va., in our collections (Fig. 7), at 22 m on a gravelly sand bottom.

Gammaropsis nitida (Stimpson) 1853

This species is amphi-Altantic in the boreal regions, being found from the Gulf of St. Lawrence south to Connecticut along the east coast of North America (Bousfield 1973). It occurred in low densities (10-20/m²) at two of our stations on Nantucket Shoals (Fig. 7). According to Bousfield (1973), *G. nitida* prefers rocky bottoms and is found to 50 m. Our collections were from 62 and 77 m on sand bottoms. The scarcity of this species in our samples is most likely due to its preference for rocky substrata, which we did not sample.

Lembos smithi Holmes 1905

This species has been reported from Cape Cod to Florida on wharves, pilings, and eelgrass to depths over 20 m (Bousfield 1973). *Lembos smithi* occurred at two of our stations in Vineyard Sound (Fig. 8) at 26 and 37 m on sand and sand-gravel bottoms in low densities (7-50/m²). The scarcity of this species in our collections is undoubtedly due to its preference for substrata which we did not sample.

Lembos websteri Bate 1856

This species has been reported to occur from Cape Cod to Florida and to 30 m (Bousfield 1973). We collected *L. websteri* in low densities (2-8/m²) at a station in Vineyard Sound and two stations off Norfolk, Va., (Fig. 8). These three stations occurred between 21 and 37 m on sand-gravel and sand bottoms. This species occurs most frequently on algal bottoms (Bousfield 1973) which explains its scarcity in our soft-bottom samples.

Leptocheirus pinguis (Stimpson) 1853

Geographic Distribution. This species has been collected between Labrador and North Carolina along the American Atlantic coast (Bousfield 1973; Fox and Bynum 1975). In our collections from the Middle Atlantic Bight, *L. pinguis* occurred in 167 samples at 134 stations between Cape Cod and Cape Hatteras (Fig. 8). The density of this abundant species ranged between 2/m² and 3,300/m² with a mean density of 300/m². This species showed a clear trend of decreasing density from north to south, going from 410/m² in southern New England to 120/m² in the New York Bight and 20/m² in the Chesapeake Bight.

Bathymetric Distribution. According to Bousfield (1973), this species is found from the low intertidal to over 250 m. We collected *L. pinguis* between 6 and 210 m. The highest densities (220-690/m²) and the bulk of the samples (114/167) occurred between 10 and 69 m (Table 14). Although this species decreased in abundance and frequency to the south, it showed no tendency to change its bathymetric distribution with latitude.

Figure 8.—Geographic distribution of species from the family Corophiidae in the Middle Atlantic Bight.

Table 14.—Bathymetric distribution of *Leptocheirus pinguis* in samples from Middle Atlantic Bight.

Depth interval (m)	Number of samples	Mean density (No./m²)
0-9	1	30
10-19	7	690
20-29	14	250
30-39	21	220
40-49	34	690
50-59	23	220
60-69	15	290
70-79	17	140
80-89	11	20
90-99	17	30
100-124	3	90
125-149	3	7
200-299	1	2

Sediment Relationship. This species has been collected on sediments ranging from sand to silt-clay (Bousfield 1973). We found *L. pinguis* on sediments ranging from gravelly sand to silt-clay (Table 15), but the highest densities (350/m²) and the majority of the samples (123/167) occurred on sand bottoms.

Table 15.—Sediment associations of *Leptocheirus pinguis* in samples from Middle Atlantic Bight.

Sediment type	Number of samples	Mean density (No./m²)
Sand-gravel	7	80
Shell	0	—
Sand-shell	2	9
Sand	123	350
Sand-silt	28	180
Silt-clay	7	20

Leptocheirus plumulosus Shoemaker 1932

This species lives in brackish estuaries from Cape Cod to Florida in shallow water on silty bottoms (Bousfield 1973). *Leptocheirus plumulosus* occurred at four of our stations in the upper Chesapeake Bay (Fig. 8) in low to moderate densities (10-590/m²). These collections were between 7 and 16 m on silt-clay bottoms. This species' preference for brackish water accounts for its scarcity in our collections.

Microprotopus raneyi Wigley 1966

This tube-dwelling amphipod has been reported from shallow water between Cape Cod Bay and the Gulf of Mexico on sand bottoms (Bousfield 1973). We collected *M. raneyi* at a single station off Virginia on a sand bottom at 8 m (Fig. 9). The preference of this species for very shallow water probably accounts for its rarity in our samples.

Neohela monstrosa (Boeck) 1861

This cold-water species has been recorded throughout the arctic boreal regions of the North Atlantic, and it occurs south to Delaware along the east coast of North America (Shoemaker 1930; Bousfield 1973). In our collections, *N. monstrosa* occurred at a single station on the continental slope east of New Jersey in 650 m on a silty sand bottom (Fig. 9). This species is probably confined to bathyal depths in our study area, which accounts for its scarcity since we took only a few samples at those depths.

Photis dentata Shoemaker 1945

This species is distributed off the east coast of North America from Maine to Florida (Shoemaker 1945a; Bousfield 1973). *Photis dentata* occurred at 19 stations in the Middle Atlantic Bight between Cape Cod and Cape May, N.J. (Fig. 9). Its density ranged between 2/m² and 60/m² with a mean of 20/m². We found this species at stations located between 49 and 92 m with over 65% of the occurrences being >80 m (Table 16). It showed a strong preference for sand bottoms (19/21). *Photis dentata* is found in deeper water and seems to have a more southerly distribution than *P. macrocoxa*.

Table 16.—Bathymetric distribution of *Photis dentata* in samples from Middle Atlantic Bight.

Depth interval (m)	Number of samples	Mean density (No./m²)
40-49	1	10
50-59	0	—
60-69	5	10
70-79	2	4
80-89	11	30
90-99	2	30

Photis macrocoxa Shoemaker 1945

Bousfield (1973) gave the range of this species as Gulf of St. Lawrence to Virginia. In our collections, *P. macrocoxa* occurred at only six stations just south of Cape Cod (Fig. 9). According to Bousfield (1973), this species occurs subtidally to 100 m on sand and mud bottoms. Our records were distributed between 23 and 59 m on sand bottoms. It occurred in low densities (6-20/m²) at all six stations.

Protomedeia fasciata Krøyer 1842

According to Bousfield (1973), this species is found chiefly in the arctic, and has been reported south along the east coast of North America to the Gulf of St. Lawrence. Its occurrence at nine of our stations south of Cape Cod to east of Sandy Hook, N.J., (Fig. 9) extends its known distribution significantly. The mean density of *P. fasciata* was 20/m², ranging between 2/m² and 60/m². It occurred in a narrow depth interval (49-62 m) and showed a strong preference for sand bottoms (8/9).

Pseuduniciola obliquua (Shoemaker) 1949

Geographic Distribution. Bousfield (1973) gave the range of this species as the Bay of Fundy to Sandy Hook,

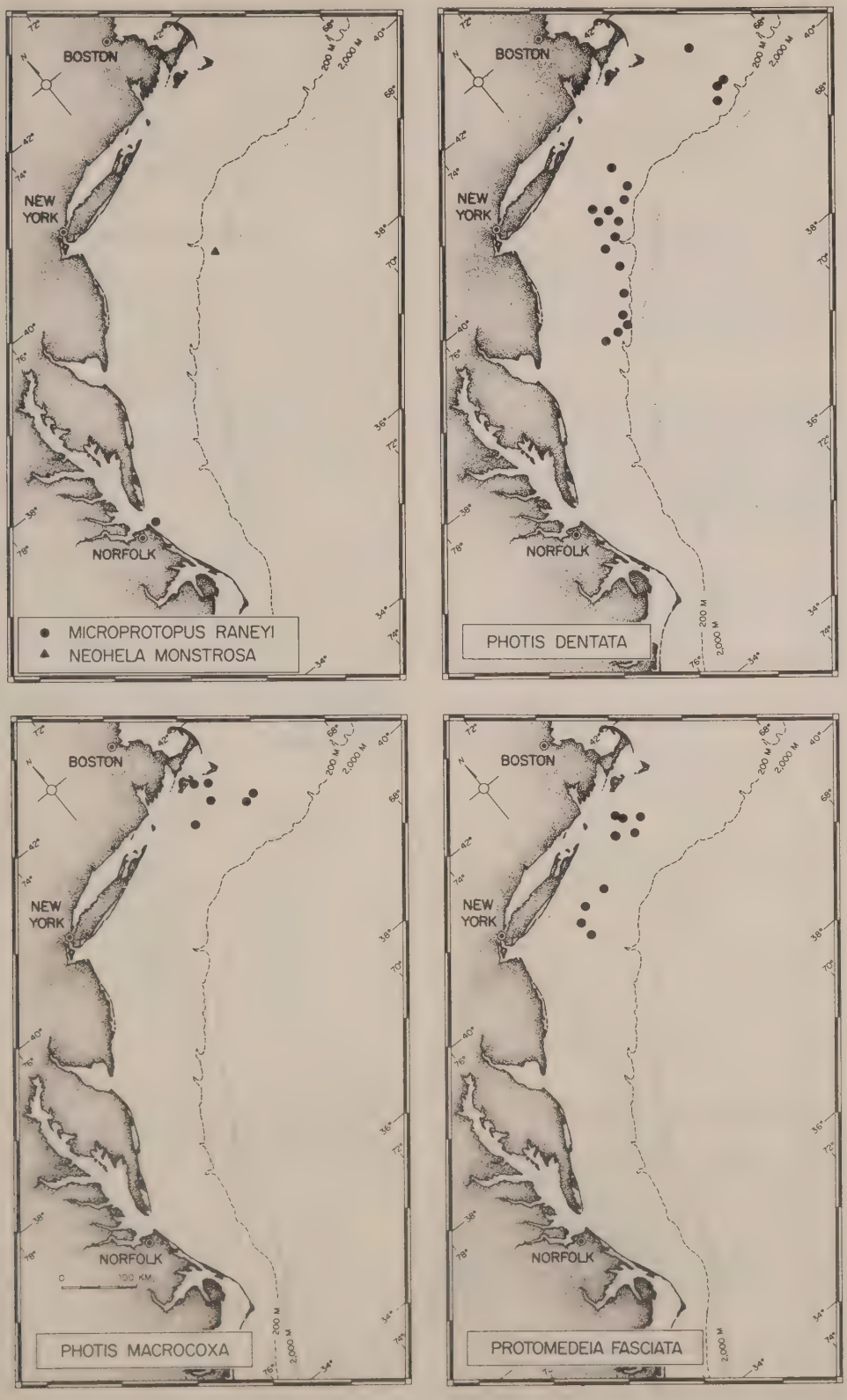

Figure 9.—Geographic distribution of species from the family Corophiidae in the Middle Atlantic Bight.

N.J. We collected *P. obliquua* at 32 stations between Cape Cod and Norfolk, Va. (Fig. 10). The 19 stations south of Sandy Hook extend the range of this species. The mean density of this species was high (110/m²), ranging between 2/m² and 1,400/m². Its mean density decreased to the south ranging from 260/m² in southern New England to 11/m² in the Chesapeake Bight.

Bathymetric Distribution. According to Bousfield (1973), *P. obliquua* occurs from low water to 50 m. We collected this species between 13 and 91 m, but the bulk of the records (28/33) were taken in <50 m (Table 17). *Pseudunciola obliquua* showed no consistent trend in its density within its depth range. Its bathymetric range did not change with latitude.

Sediment Relatonship. This tube-dwelling species has been collected on medium to coarse sand (Bousfield 1973). In our collections, *P. obliquua* occurred on sediments ranging from sand-gravel to sand-silt, but it occurred most frequently (26/33) and in the highest densities (130/m²) on sand bottoms (Table 18).

Table 17.—Bathymetric distribution of *Pseudunciola obliquua* in samples from Middle Atlantic Bight.

Depth interval (m)	Number of samples	Mean density (No./m²)
10-19	7	210
20-29	4	20
30-39	11	150
40-49	6	5
50-59	2	20
60-69	2	130
90-99	1	4

Table 18.—Sediment associations of *Pseudunciola obliquua* in samples from Middle Atlantic Bight.

Sediment type	Number of samples	Mean density (No./m²)
Sand-gravel	2	130
Shell	1	30
Sand-shell	3	10
Sand	26	130
Sand-silt	1	2
Silt-clay	0	—

Rildardanus laminosa (Pearse) 1912

This species has previously been collected in the Caribbean and the Gulf of Mexico at 40-60 m (Shoemaker 1945b). Our collections from two stations off Virginia and North Carolina (Fig. 10) extended the range of this species to the north. These records came from 77 and 80 m on shelly sand and shell bottoms. The density for *R. laminosa* was low (6/m²) at both stations.

Siphonoecetes smithianus Rathbun 1908

According to Bousfield (1973), this species has been recorded from only a few localities between the south side of Cape Cod and New Jersey. We collected *S. smithianus* at 16 stations between Cape Cod and Maryland (Fig. 10). This species was in low density at all stations with a mean of 9/m², ranging between 2/m² and 40/m². It occurred between 13 and 86 m, but was most common (11/16) between 40 and 60 m. The collections of this species came from shelly sand (2/16), silty sand (1/16), and sand (13/16) bottoms.

Unciola inermis Shoemaker 1945

Geographic Distribution. This species has been reported between the Bay of Fundy and the mouth of Chesapeake Bay (Shoemaker 1945b). We collected 106 samples at 92 stations between Cape Cod and Cape Charles (Fig. 10). *Unciola inermis* was abundant with a mean density of 560/m², ranging between 2/m² and 6,100/m². The mean density of this species was highest in southern New England (1,250/m²) and decreased substantially in the New York (230/m²) and Chesapeake (220/m²) Bights.

Bathymetric Distribution. Shoemaker (1945b) found this species between low water and 200 m, but the majority of his records came from about 60 m. We collected *U. inermis* between 14 and 84 m, but the highest densities (720-1,000/m²) and the majority of the samples (71/106) occurred between 30 and 59 m (Table 19). This species was found at greater depths (>70 m) in the southern portion of its range, showing a clear pattern of submergence.

Table 19.—Bathymetric distribution of *Unciola inermis* in samples from Middle Atlantic Bight.

Depth interval (m)	Number of samples	Mean density (No./m²)
10-19	1	20
20-29	8	200
30-39	14	1,000
40-49	31	720
50-59	26	720
60-69	15	170
70-79	8	30
80-89	3	6

Sediment Relationship. According to Bousfield (1973), *U. inermis* occurs on sand and silty sand sediments. We collected this species on sediments ranging from sand-gravel to sand (Table 20). The highest mean density oc-

Table 20.—Sediment associations of *Unciola inermis* in samples from Middle Atlantic Bight.

Sediment type	Number of samples	Mean density (No./m²)
Sand-gravel	11	1,600
Shell	3	10
Sand-shell	11	210
Sand	81	490
Sand-silt	0	—
Silt-clay	0	—

Figure 10.—Geographic distribution of species from the family Corophiidae in the Middle Atlantic Bight.

curred on sand-gravel (1,600/m²), but the largest number of samples (81/106) occurred on sand bottoms.

Unciola irrorata Say 1818

Geographic Distribution. This species has been reported from the Gulf of St. Lawrence to South Carolina along the eastern coast of North America (Shoemaker 1945b). It was ubiquitous in our study area occurring in 216 samples from 189 stations between Cape Cod and Cape Hatteras (Fig. 10). The density of this species ranged between 2/m² and 4,900/m² with a mean of 100/m². Its mean density decreased from 220/m² in southern New England to 40/m² in the New York Bight to 20/m² in the Chesapeake Bight, showing a clear trend of decreasing abundance from north to south.

Bathymetric Distribution. Shoemaker (1945b) reported *U. irrorata* has previously been collected between low water and 300 m. We collected this species between 6 and 500 m. However, the majority of the records (169/216) and the highest mean densities (70-230/m²) were found between 10 and 70 m (Table 21). The bathymetric distribution of this species did not change with latitude.

Table 21.—Bathymetric distribution of *Unciola irrorata* in samples from Middle Atlantic Bight.

Depth interval (m)	Number of samples	Mean density (No./m²)
0-9	3	70
10-19	22	120
20-29	26	170
30-39	33	70
40-49	38	70
50-59	27	230
60-69	22	90
70-79	15	30
80-89	13	50
90-99	8	30
100-124	2	3
125-149	3	9
150-199	2	26
>200	2	5

Sediment Relationship. According to Bousfield (1973), this species is usually found on coarse to medium sand sediments. We collected *U. irrorata* on a wide variety of sediment types ranging from sand-gravel to silt-clay (Table 22). The largest number of samples (159/216) came from sand bottoms, and the highest mean density was found on sand-gravel sediments.

Table 22.—Sediment associations of *Unciola irrorata* in samples from Middle Atlantic Bight.

Sediment type	Number of samples	Mean density (No./m²)
Sand-gravel	14	200
Shell	6	20
Sand-shell	17	30
Sand	159	110
Sand-silt	18	60
Silt-clay	2	10

Unciola laticornis Hansen 1887

According to Shoemaker (1945b), this species occurs in deep water (100-3,000 m) between Nova Scotia and Virginia. We collected a single specimen of this abyssal amphipod at 1,995 m on a silt bottom east of Virginia (Fig. 11).

Unciola leucopis (Krøyer) 1845

This arctic boreal species is widely distributed in the North Atlantic and has previously been recorded as far south as Georges Bank off the east coast of North America (Shoemaker 1945b). Our collections from nine stations distributed along the outer continental shelf and upper continental slope between Massachusetts and New Jersey (Fig. 11) extend the range of this species to the south. These records were distributed between 62 and 450 m on sand (8/9) and silty sand (1/9) sediments. This cold-water species shows some evidence of southern submergence since the five northernmost records are in <100 m and the four southernmost records are below 200 m.

Unciola serrata Shoemaker 1945

Shoemaker (1945b) found this species in shallow coastal waters from Vineyard Sound to Georgia. In our collections, *U. serrata* occurred in low densities (4-100/m²) at five stations between Vineyard Sound and Delaware Bay (Fig. 11). It was found between 16 and 54 m on gravel, shelly sand, sand, and clayey silt bottoms.

Unciola spicata Shoemaker 1945

Shoemaker (1945b) gave the geographic range of this species as New Jersey to Florida. We collected *U. spicata* at nine stations along the outer edge of the continental shelf between Long Island and Cape Hatteras (Fig. 11). Shoemaker (1945b) found this species between 40 and 800 m, but the majority of his records occurred around 200 m. In our collectons, *U. spicata* occurred in low densities (10/m²) between 80 and 194 m on sand (5/10), silty sand (4/10), and shell (1/10) bottoms.

Unciola sp. A

An undescribed species of *Unciola* was collected in 11 samples from 10 stations on the outer portion of the continental shelf (Fig. 11). Nine of the 10 stations were north of New Jersey indicating this species probably has a subarctic-boreal distribution. Its density was low at all 10 stations, ranging between 2/m² and 50/m² with a mean density of 20/m². We collected it between 90

Figure 11.—Geographic distribution of species from the family Corophiidae in the Middle Atlantic Bight.

and 316 m on sand (3/11) and sand-silt (8/11) sediments.

Unciola sp. B

Single specimens of an undescribed species of *Unciola* were collected at four stations between New Jersey and Cape Hatteras on the continental slope (Fig. 11). These stations were located between 400 and 505 m on silty sand sediments.

Family EUSIRIDAE

Pontogeneia inermis (Krøyer) 1938

Geographic Distribution. This species is widely distributed in the arctic boreal regions, and it has previously been recorded as far south as Long Island off the east coast of North America (Bousfield 1973). We collected *P. inermis* at 15 stations extending from Cape Cod to Virginia (Fig. 12). The three records between Long Island and Virginia constitute a southern range extension for this species. *Pontogeneia inermis* was moderately abundant with a mean density of 80/m² ranging from 2/m² to 700/m². The three southern stations had low densities (2-8/m²).

Bathymetric Distribution. Pontogeneia inermis is reported to occur between the low intertidal and depths over 10 m. We collected this species in samples from between 18 and 73 m with the highest densities (380/m²), occurring between 40 and 49 m (Table 23). It is worth noting that our records of this species are from significantly greater depths than the bathymetric range suggested by Bousfield (1973). The most likely explanation is that *P. inermis* submerges in the southern portion of its range.

Table 23.—Bathymetric distribution of *Pontogeneia inermis* in samples from Middle Atlantic Bight.

Depth interval (m)	Number of samples	Mean density (No./m²)
10-19	1	2
20-29	6	20
30-39	2	3
40-49	3	380
50-59	0	—
60-69	4	20
70-79	1	20

Sediment Relationship. Bousfield (1973) reported that this species is pelagic and epibenthic, and that it clings to submerged plants and algae. In our collections, *P. inermis* occurred most frequently on sand bottoms (8/17), but its density was highest (240/m²) on gravelly sediments (Table 24). It seems likely that in the deeper waters from which we collected this species it clings to hydroids, bryozoans, and other plantlike invertebrates, since there are no macroalgae at these depths.

Table 24.—Sediment associations of *Pontogeneia inermis* in samples from Middle Atlantic Bight.

Sediment type	Number of samples	Mean density (No./m²)
Sand-gravel	5	240
Shell	1	8
Sand-shell	2	50
Sand	8	10
Sand-silt	1	2
Silt-clay	0	—

Rhachotropis inflata (G. O. Sars) 1882

This species has previously been recorded in the North Atlantic and northeast Pacific and in the western Atlantic; it occurs from the Arctic to the Gulf of St. Lawrence (Barnard 1971; Bousfield 1973). A single specimen was found in our collections from a station located offshore of Chesapeake Bay at a depth of 104 m on a sand-shell bottom (Fig. 12). Although this record extends the range of this species, *R. inflata* is clearly rare south of Cape Cod.

Family GAMMARIDAE

Casco bigelowi (Blake) 1929

Geographic Distribution. According to Bousfield (1973), this species has been collected from the Gulf of St. Lawrence to New Jersey off the east coast of North America. In our collections from the Middle Atlantic Bight, *C. bigelowi* occurred in 41 samples from 32 stations located between Cape Cod and Maryland (Fig. 13). It was found in low densities at all stations with a mean of 20/m², ranging between 2/m² and 60/m². This species is much more common in the northern part of our study area, but the single deep water (400 m) record off Maryland does constitute a slight southerly extension of its range.

Bathymetric Distribution. Bousfield (1973) gave the depth range of this species as low intertidal to >50 m. We collected *C. bigelowi* between 33 and 400 m with the bulk of our collections (37/41) occurring between 40 and 100 m (Table 25). The discrepancy between the depth

Table 25.—Bathymetric distribution of *Casco bigelowi* in samples from Middle Atlantic Bight.

Depth interval (m)	Number of samples	Mean density (No./m²)
30-39	2	30
40-49	6	40
50-59	6	20
60-69	6	30
70-79	10	10
80-89	4	10
90-99	5	20
100-124	1	10
300-499	1	2

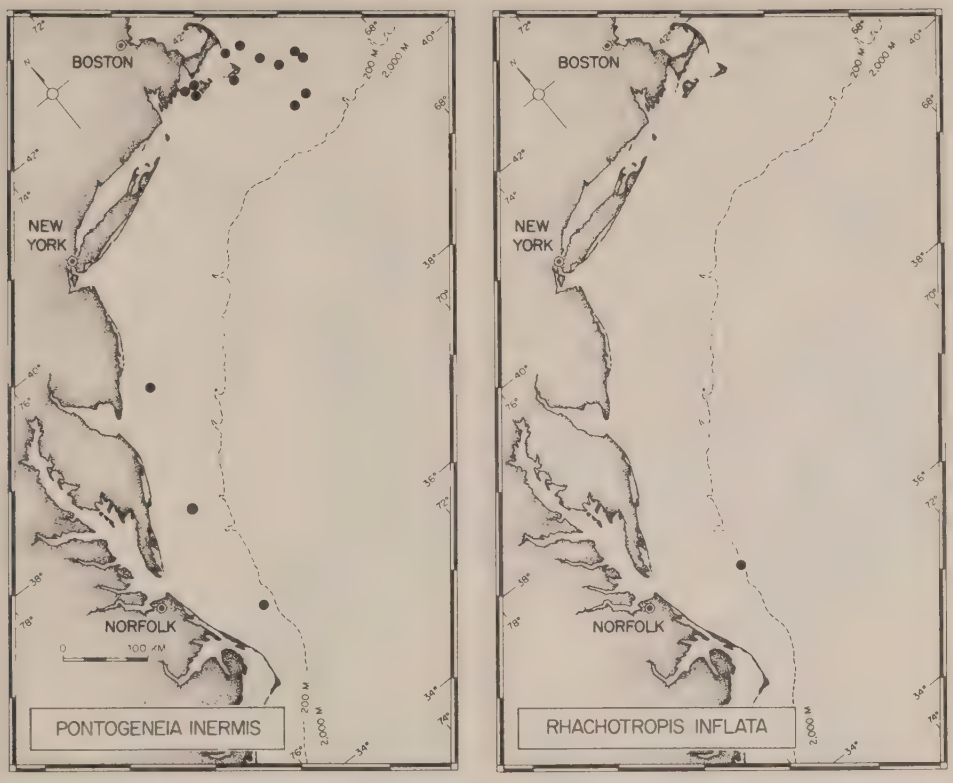

Figure 12.—Geographic distribution of species from the family Eusiridae in the Middle Atlantic Bight.

range reported by Bousfield and our findings may be the result of submergence of this species in the southern portion of its range.

Sediment Relationship. Bousfield (1973) reported that this species is most commonly found on mud and gravel bottoms. We found *C. bigelowi* on sand (28/41), sand-silt (9/41), and silt-clay (4/41) sediments (Table 26).

Table 26.—Sediment associations of *Casco bigelowi* in samples from Middle Atlantic Bight.

Sediment type	Number of samples	Mean density (No./m²)
Sand-gravel	0	—
Shell	0	—
Sand-shell	0	—
Sand	28	30
Sand-silt	9	9
Silt-clay	4	20

Elasmopus levis Smith 1873

According to Bousfield (1973), this intertidal and shallow-water amphipod occurs on rocky shores between Cape Cod and northern Florida. It occurred in only two of our samples: off New York and in the lower Chesapeake Bay (Fig. 13). Both of these stations were in shallow water (8-13 m) on gravelly bottoms. The scarcity of *E. levis* in our collections is undoubtedly due to its preference for rocky intertidal areas.

Eriopisa elongata (Bruzelius) 1859

Geographic Distribution. According to Barnard (1971), this species is known from Iceland, Europe, and the northeast Pacific. Our collections from the Middle Atlantic Bight seem to be the first records of this species from the east coast of North America. *Eriopisa elongata* occurred in 28 samples from 25 stations between Cape Cod and Cape May on the outer portion of the continental shelf (Fig. 13), and in low densities with a mean of 10/m², ranging between 2/m² and 60/m².

Bathymetric Distribution. Barnard (1971) gave a depth range between 100 and 800 m for this species in the Atlantic Ocean. In our collections, *E. elongata* occurred between 64 and 188 m, but it was most common (16/28) between 80 and 100 m (Table 27).

Sediment Relationship. In our samples, this species was found on shelly sand (1/28), sand (15/28), silty sand (9/28), and silt-clay (3/28) sediments (Table 28).

Gammarus annulatus Smith 1873

Geographic Distribution. This species has been

Figure 13.—Geographic distribution of species from the family Gammaridae in the Middle Atlantic Bight.

Table 27.—Bathymetric distribution of *Eriopisa elongata* in samples from Middle Atlantic Bight.

Depth interval (m)	Number of samples	Mean density (No./m²)
60-69	2	5
70-79	2	8
80-89	8	8
90-99	8	20
100-124	2	20
125-149	3	10
150-199	3	10

Table 28.—Sediment associations of *Eriopisa elongata* in samples from Middle Atlantic Bight.

Sediment type	Number of samples	Mean density (No./m²)
Sand-gravel	0	—
Shell	0	—
Sand-shell	1	2
Sand	15	10
Sand-silt	9	10
Silt-clay	3	10

reported in open coastal areas from Nova Scotia to Long Island Sound (Bousfield 1973). We collected this species in 21 samples from 14 stations in the Nantucket Shoals area (Fig. 13). *Grammarus annulatus* was relatively abundant in the area in which it occurred, with a mean density of 90/m², ranging between 10/m² and 630/m².

Bathymetric Distribution. According to Bousfield (1973), *G. annulatus* is primarily pelagic, but its occurrence in relatively high numbers in our grab samples indicate that it must sometimes be benthic or epibenthic. We collected *G. annulatus* in samples between 15 and 183 m. The highest density (190/m²) and the largest number of samples (6/21) occurred between 30 and 39 m (Table 29).

Table 29.—Bathymetric distribution of *Gammarus annulatus* in samples from Middle Atlantic Bight.

Depth interval (m)	Number of samples	Mean density (No./m²)
10-19	1	90
20-29	2	10
30-39	6	190
40-49	3	70
50-59	1	20
60-69	3	90
70-79	2	10
80-89	0	—
90-99	1	30
150-199	2	10

Sediment Relationship. This species has been reported primarily from sand sediments (Bousfield 1973). Our collections of *G. annulatus* were predominately on sand (19/21), but it also occurred on gravelly sand (1/21) and silt-clay (1/21).

Gammarus daiberi Bousfield 1969

This species occurs in the brackish portions of estuaries from Long Island Sound to South Carolina (Bousfield 1973). We collected *G. daiberi* at four stations: one from the Connecticut River, two from the Upper Chesapeake, and one from Albemarle Sound (Fig. 13). The density was high (1,200/m²) in the Connecticut River, but low (10/m²) at the other stations. All four stations were in shallow water (5-8 m). The station in the Connecticut River was on a sand bottom, but the other three stations were on silt-clay bottoms.

Gammarus mucronatus Say 1818

This shallow-water species has been found between the Gulf of St. Lawrence and the Gulf of Mexico (Bousfield 1973). It is primarily an intertidal form in salt marshes and estuaries, but it occurs subtidally in brackish waters (Bousfield 1973). Since we did little collecting in its preferred habitats, it is not surprising that *G. mucronatus* occurred only twice in our samples (Fig. 13). Single specimens were taken in the upper Chesapeake (7 m—clayey silt) and in Pamlico Sound (4 m—sand).

Gammarus tigrinus Sexton 1939

This species occurs in the upper reaches of estuaries between the Gulf of St. Lawrence and North Carolina (Bousfield 1973; Fox and Bynum 1975). We collected three specimens from a single station in Buzzards Bay on a silt-clay bottom at 15 m (Fig. 13).

Maera danae Stimpson 1853

This epibenthic species is known from the American Atlantic, from the Gulf of St. Lawrence to New Jersey (Bousfield 1973). We collected *M. danae* in low to moderate densities at two stations: one from Narragansett Bay (150/m²) and the other offshore of Long Island (2/m²) (Fig. 14). The Narragansett Bay station was at 13 m on a shell bottom, and the Long Island station was at 49 m on a sand bottom.

Melita dentata (Krøyer) 1842

This subarctic boreal species is widely distributed in the North Atlantic, and it has previously been recorded as far south as Cape Cod Bay on gravel bottoms from low water to 300 m (Bousfield 1973). Our collections from 10 stations between Cape Cod and Maryland extend the range of this species to the south (Fig. 14). *Melita dentata* occurred in low densities (2-40/m²) between 46 and 70 m on sand (8/10), gravel (1/10), and shell (1/10) bottoms.

Melita nitida Smith 1873

This species occurs in the mesohaline portions of estuaries between the Gulf of St. Lawrence and the Gulf of

Figure 14.—Geographic distribution of species from the family Gammaridae in the Middle Atlantic Bight.

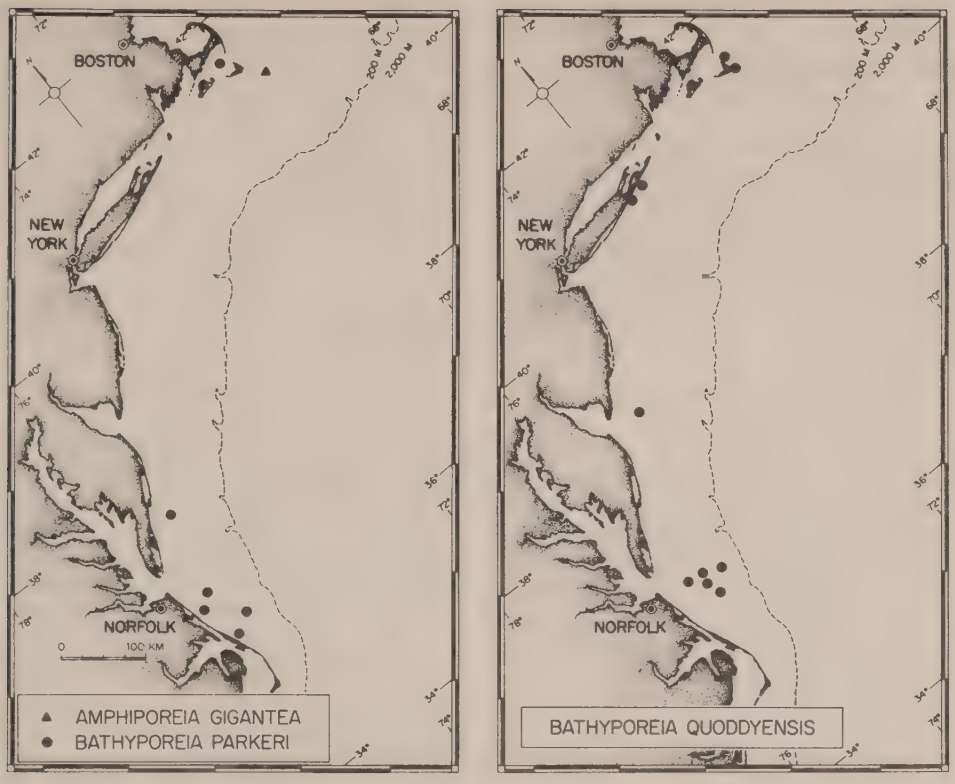

Figure 15.—Geographic distribution of species from the family Haustoriidae, subfamily Pontoporelinae in the Middle Atlantic Bight.

Mexico (Bousfield 1973). In our collections, *M. nitida* occurred in low to moderate densities (10-260/m²) at stations in the Hudson River, off Staten Island, and in the upper Chesapeake Bay (Fig. 14). The depth at these stations ranged between 8 and 16 m, and the sediment types represented were sand, shelly silt-clay, and silt-clay.

Melita sp. A

An undescribed species of the genus *Melita* was collected in 13 samples from 12 stations between Cape Cod and New Jersey (Fig. 14). The density of this species was low (2-20/m²) at all stations. It was rather evenly distributed between 68 and 97 m. These samples occurred on sand (9/13), silty sand (3/13), and shell (1/13) bottoms.

Family HAUSTORIIDAE

Subfamily PONTOPOREIINAE

Amphiporeia gigantea Bousfield 1973

Bousfield (1973) found this species between Cape Cod and Sandy Hook, N.J., on sand bottoms in 10-15 m. We collected two specimens of *A. gigantea* at a single station southeast of Nantucket in 37 m on a sand bottom (Fig. 15).

Bathyporeia parkeri Bousfield 1973

According to Bousfield (1973), this species occurs from the south side of Cape Cod to northern Florida on exposed sand beaches to 10 m depth. We collected this species at six stations between Cape Cod and Virginia (Fig. 15). *Bathyporeia parkeri* occurred in low densities (2-6/m²) at all these stations. Our collections were slightly deeper than Bousfield's, from 20 to 30 m, and all the stations were on sand bottoms.

Bathyporeia quoddyensis Shoemaker 1949

This species has been collected between Nova Scotia and Chesapeake Bay on fine sand to 40 m (Bousfield 1973). *Bathyporeia quaddyensis* occurred at 10 stations between Cape Cod and Virginia in our collections (Fig. 15). The density of this species was low (2-30/m²) except for a single station off Nantucket where a density of 900/m² occurred. The collections of this species were made between 13 and 30 m on sand sediments.

Subfamily HAUSTORIINAE

Acanthohaustorius intermedius Bousfield 1965

This species has been reported from Cape Cod Bay to northern Florida on fine sands to 40 m (Bousfield 1973). We collected *A. intermedius* at 17 stations between Cape Cod and Cape Hatteras (Fig. 16). Its density at these stations was low to moderate (2-170/m²) with a mean of 30/m². Our samples were rather evenly distributed between 7 and 40 m. All 17 stations were on sand bottoms.

Acanthohaustorius spinosus Bousfield 1962

This species has previously been collected between Nova Scotia and the south side of Cape Cod on coarse and medium sand to depths of 200 m (Bousfield 1973). In our collections, *A. spinosus* occurred in low densities (2-30/m²) at 14 stations between Cape Cod and Cape May, N.J. (Fig. 16). *Acanthohaustorius spinosus* was found between 23 and 74 m, but occurred most frequently (10/15) between 30 and 49 m. All the stations were on sand bottoms. The eight records south of Long Island extend the range of this species to the south.

Acanthohaustorius sp. A

This new species of *Acanthohaustorius* is currently being described by Ann Frame of National Marine Fisheries Service (NMFS) Sandy Hook Laboratory, Highlands, N.J. We collected single specimens of this species from stations off New Jersey and Virginia in 20 and 23 m on sand bottoms (Fig. 16).

Acanthohaustorius sp. B

Geographic Distribution. This species which is an offshore cognate of *A. millsi* is presently being described by Ann Frame of the NMFS Sandy Hook Laboratory, Highlands, N.J. We collected *Acanthohaustorius* sp. B in 36 samples from 35 stations between Cape Cod and Cape Hatteras (Fig. 16). This moderately abundant species had a mean density of 80/m², ranging between 2/m² and 1,000/m². The abundance of this species showed no evidence of latitudinal trends within our study area.

Bathymetric Distribution. We collected *Acanthohaustorius* sp. B between 9 and 74 m. It occurred most frequently (34/36), and in the highest densities (40-140/m²) between 10 and 49 m (Table 30). The bathymetric distribution of this species showed no tendency to change with latitude.

Sediment Relationship. *Acanthohaustorius* sp. B was most often associated with sand sediment (34/36), but also occurred on sand-shell (1/36) and sand-gravel (1/36).

Table 30.—Bathymetric distribution of *Acanthohaustorius* sp. B in samples from Middle Atlantic Bight.

Depth interval (m)	Number of samples	Mean density (No./m²)
0-9	1	20
10-19	6	80
20-29	11	140
30-39	14	40
40-49	3	70
70-79	1	8

Acanthohaustorius sp. C

An undescribed species of *Acanthohaustorius* was found at 10 stations in our Middle Atlantic Bight collections (Fig. 16). The majority of the stations (8/10) were located near the mouth of Chesapeake Bay. Its numerical density varied between 4/m² and 60/m² with a mean of 20/m². We collected this species between 10 and 37 m on sand (8/10) and shell (2/10) sediments.

Parahaustorius attenuatus Bousfield 1965

Bousfield (1973) reported that this species has been found from Georges Bank south to Chesapeake Bay on clean sand to depths of >50 m. We collected this species at 11 stations between Cape Cod and Virginia (Fig. 17). The mean density of *P. attenuatus* was 30/m², ranging between 2/m² and 170/m². We found this species between 12 and 74 m, but the majority of the collections (8/11) were between 20 and 40 m. All our records of *P. attenuatus* were from sand bottoms.

Parahaustorius holmesi Bousfield 1965

This species has been collected between Georges Bank and the mouth of the Chesapeake on fine clean sand in depths between 20 and 50 m (Bousfield 1973). In our collections, *P. holmesi* occurred at three stations between Cape Cod and Long Island (Fig. 17). The densities of this species at these stations was low (8-40/m²). The stations occurred between 16 and 46 m on sand bottoms.

Protohaustorius deichmannae Bousfield 1965

Geographic Distribution. This species has been recorded from Maine to South Carolina (Bousfield 1973). We collected *P. deichmannae* at 34 stations between Cape Cod and Cape Hatteras (Fig. 17). This moderately abundant species had a mean density of 50/m², ranging from 2/m² to 270/m². This warm-water species occurred more frequently in the southern portion of our study area; i.e., southern New England (4/34), New York Bight (11/34), and Chesapeake Bight (19/34).

Bathymetric Distribution. Bousfield (1973) reported that this species occurs subtidally to about 20 m. In our

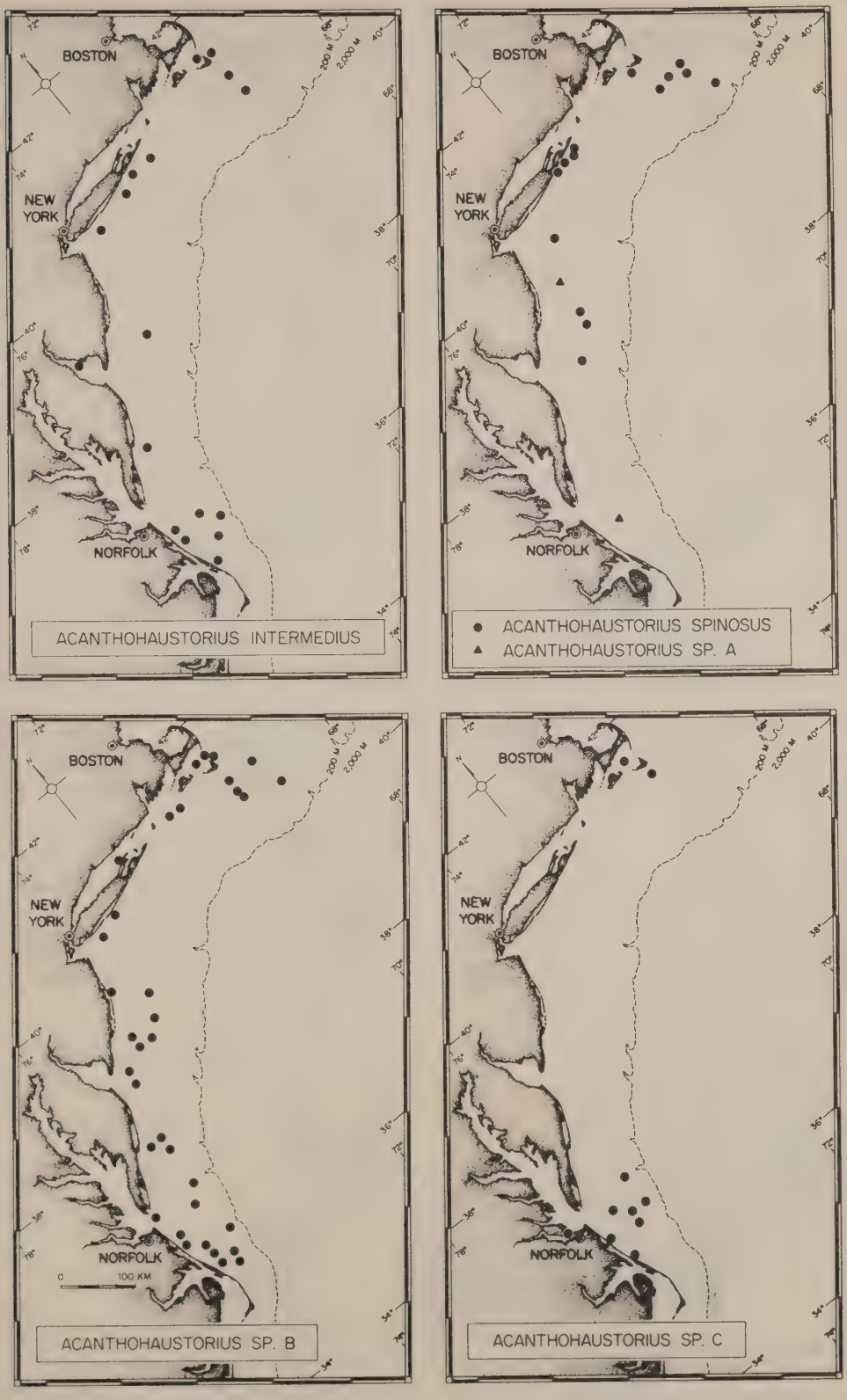

Figure 16.—Geographic distribution of species from the family Haustoriidae, subfamily Haustoriinae in the Middle Atlantic Bight.

Figure 17.—Geographic distribution of species from the family Haustoriidae, and subfamily Haustoriinae in the Middle

samples, *P. deichmannae* occurred between 7 and 37 m with the highest densities (50-80/m²) occurring in <30 m (Table 31). Eight of the nine stations >30 m occurred in the Chesapeake Bight, suggesting that this species occurs at slightly greater depths in the warmer southern waters.

Table 31.—Bathymetric distribution of *Protohaustorius deichmannae* in samples from Middle Atlantic Bight.

Depth interval (m)	Number of samples	Mean density (No./m²)
0-9	2	80
10-19	14	70
20-29	9	50
30-39	9	20

Sediment Relationship. This species has been found on fine sand or silty-sand (Bousfield 1973). We collected *P. deichmannae* on sand (26/34), shelly sand (6/34), shell (1/34), and silty sand (1/34).

Protohaustorius wigleyi Bousfield 1965

Geographic Distribution. This species has been reported to occur from Maine to North Carolina along the American Atlantic coast (Bousfield 1965). We collected *P. wigleyi* in 88 samples from 80 stations between Cape Cod and Cape Hatteras (Fig. 17). The mean density of this species was 40/m², ranging between 2/m² and 270/m². *Protohaustorius wigleyi* showed no consistent change in density with latitude, but it did occur more frequently in the southern portion of our study area.

Bathymetric Distribution. Bousfield (1973) found *P. wigleyi* from shoreline to 150 m. In our collections, this species occurred between 12 and 91 m. The mean densities showed no clear trends with depth, but the bulk of the samples were found between 20 and 49 m (Table 32). *Protohaustorius wigleyi* showed no evidence of changing its depth distribution with latitude.

Table 32.—Bathymetric distribution of *Protohaustorius wigleyi* in samples from Middle Atlantic Bight.

Depth interval (m)	Number of samples	Mean density (No./m²)
10-19	5	40
20-29	23	30
30-39	25	70
40-49	17	30
50-59	8	30
60-69	5	10
70-79	4	50
80-89	0	—
90-99	1	6

Sediment Relationship. This species is usually associated with sandy sediments (Bousfield 1973). In our collections, it was found on gravelly sand (1/88), shelly sand (9/88), shell (1/88), and sand (77/88) bottoms (Table 33).

Table 33.—Sediment associations of *Protohaustorius wigleyi* in samples from Middle Atlantic Bight.

Sediment type	Number of samples	Mean density (No./m²)
Sand-gravel	1	20
Shell	1	70
Sand-shell	9	20
Sand	77	40
Sand-silt	0	—
Silt-clay	0	—

Pseudohaustorius borealis Bousfield 1965

Geographic Distribution. This species has been collected between Georges Bank and Virginia (Bousfield 1973). In our collections, *P. borealis* occurred in 27 samples at 24 stations between Cape Cod and Virginia (Fig. 17). This species was moderately abundant where it occurred, with a mean density of 50/m², ranging between 2/m² and 600/m².

Bathymetric Distribution and Sediment Relationship. Bousfield (1973) found this species on medium to coarse sands between 10 and 60 m. In our samples, *P. borealis* occurred between 22 and 62 m, but the majority of the collections (19/27) and the highest densities (50-70/m²) came from between 20 and 39 m (Table 34). All 24 stations were located on sand bottoms.

Table 34.—Bathymetric distribution of *Pseudohaustorius borealis* in samples from Middle Atlantic Bight.

Depth interval (m)	Number of samples	Mean density (No./m²)
20-29	7	50
30-39	12	70
40-49	6	10
50-59	1	10
60-69	1	10

Family ISCHYROCERIDAE

Cerapus tubularis Say 1818

This species occurs from Cape Cod to eastern Florida on muddy sand to depths of 30 m (Bousfield 1973). We collected *C. tubularis* at two stations in Delaware Bay at shallow depths (4-9 m) on silty sand sediments (Fig. 18). The scarcity of *C. tubularis* in our collections is most likely due to its preference for depths shallower than 10 m where we took few samples.

Ericthonius brasiliensis (Dana) 1853

This tube-dwelling species has been reported from Cape Cod to the West Indies in bays and estuaries

Figure 18.—Geographic distribution of species from the family Ischyroceridae in the Middle Atlantic Bight.

(Bousfield 1973). We collected *E. brasiliensis* at four stations: two from Vineyard Sound and two from Chesapeake Bay (Fig. 18). These records occurred between 10 and 37 m on sand, gravel, and shelly bottoms. Its density at the four stations ranged from 4/m² to 125/m². The scarcity of records of *E. brasiliensis* in our collections is undoubtedly due to the small number of our samples taken in estuaries.

Ericthonius rubricornis Smith 1873

Geographic Distribution. This amphi-Atlantic species has previously been recorded in the western Atlantic, between the Gulf of St. Lawrence and Long Island Sound (Bousfield 1973). In our collections from the Middle Atlantic Bight, *E. rubricornis* occurred in 59 samples from 53 stations between Cape Cod and Cape Hatteras (Fig. 18). The 39 records south of Long Island extend the range of this species to Cape Hatteras. *Ericthonius rubricornis* has a mean density of 30/m², ranging between 2/m² and 720/m².

Bathymetric Distribution. Bousfield (1973) reported that this species may be found from low water to over 200 m. In our collections, *E. rubricornis* occurred between 40 and 376 m with the bulk of the records (44/59) occurring between 50 and 89 m (Table 35). The density of this species was quite low (2-12/m²) at the stations below 100 m.

Table 35.—Bathymetric distribution of *Ericthonius rubricornis* in samples from Middle Atlantic Bight.

Depth interval (m)	Number of samples	Mean density (No./m²)
40-49	5	10
50-59	11	10
60-69	10	20
70-79	12	30
80-89	11	100
90-99	3	30
100-124	1	4
124-149	1	2
150-199	1	2
200-299	3	10
300-499	1	2

Sediment Relationship. This tube-dwelling amphipod lives primarily on sand bottoms (Bousfield 1973). We collected *E. rubricornis* on sediments ranging from gravel to sand-silt-clay, but the bulk (48/59) of the samples and the highest densities (40/m²) occurred on sand bottoms (Table 36).

Ischyrocerus anguipes Krøyer 1838

According to Bousfield (1973), this tube-dwelling species occurs along the American Atlantic coast south to Cape Hatteras on hard substrata to depths >50 m. In our Middle Atlantic Bight collections, this species occurred at 11 stations between Cape Cod and Maryland (Fig. 18) in low to moderate densities (4-370/m²). The stations where *I. anguipes* occurred ranged between 18 and 63 m. We found this species on both sand (6/12) and gravel (6/12) bottoms, but the mean densities on gravel (100/m²) were much higher than on sand (10/m²). Since *I. anguipes* occurs most frequently on hard substrata (i.e., rocks, pilings, and aids to navigation), it is probably much more common than our grab sampling indicates.

Jassa falcata (Montagu) 1818

This tube-dwelling amphipod is a dominant fouling organism which is cosmopolitan in temperate and warm temperate seas (Barnard 1969). Along the North American Atlantic coast, *J. falcata* occurs northward to Newfoundland (Bousfield 1973). We collected this species at a single station in the lower Chesapeake (Fig. 18), but it is known to be a common species on hard substrata throughout our study area.

Table 36.—Sediment associations of *Erichthonius rubricornis* in samples from Middle Atlantic Bight.

Sediment type	Number of samples	Mean density (No./m²)
Sand-gravel	1	4
Shell	3	10
Sand-shell	5	10
Sand	48	40
Sand-silt	2	2
Silt-clay	0	—

Family LILJEBORGIIDAE

Idunella sp. A

This species did not correspond to the description of any known member of the genus *Idunella*. *Idunella* sp. A occurred at nine stations between Cape Cod and Cape Hatteras along the outer edge of the continental shelf (Fig. 19). Its density was uniformly low (2-10/m²). The collections of this undescribed species occurred between 121 and 225 m on sand (6/11), silty-sand (4/11), and shell (1/11) sediments.

Liljeborgia sp. A

These specimens could not be positively identified as any known species of *Liljeboria*. They did bear a close resemblance to *L. kinahani*, but they differed in several important morphological features. We collected this species at four stations between Cape May and Cape Hatteras (Fig. 19). Its density was low (3-40/m²) at all stations. This species was distributed between 20 and 40 m on sand (3/4) and sand-gravel (1/4) sediments.

Listriella barnardi Wigley 1966

According to Bousfield (1973), this species is distributed from the south side of Cape Cod to Georgia. It

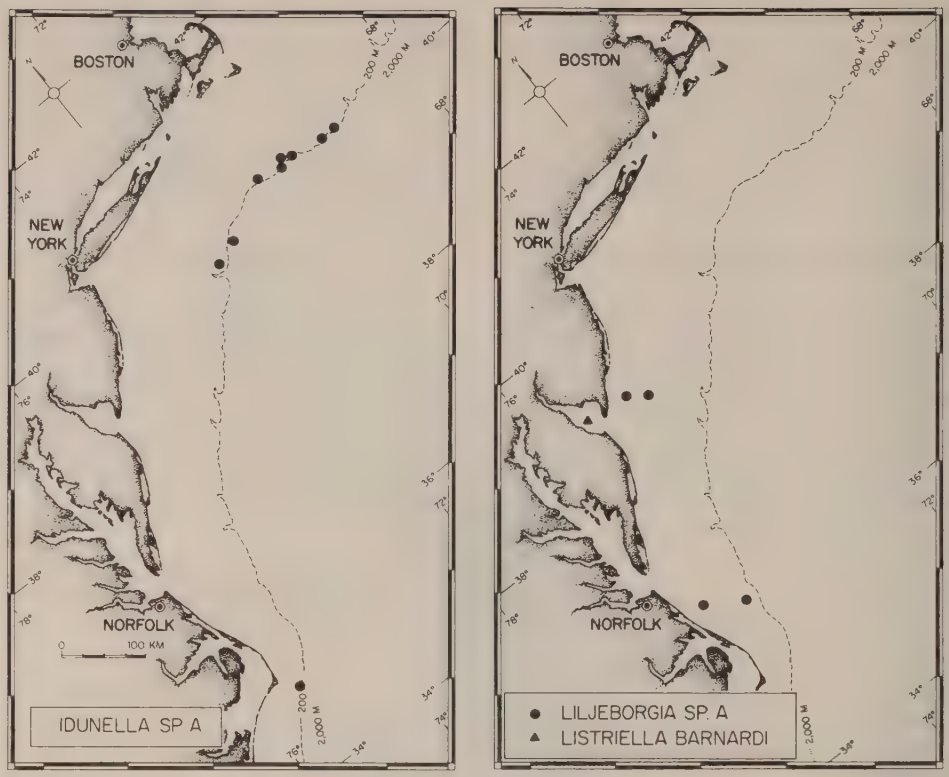

Figure 19.—Geographic distribution of species from the family Liljeborgiidae in the Middle Atlantic Bight.

lives in the tubes of polychaetes (e.g., *Amphitrite ornata*) in low intertidal and shallow subtidal depths. We collected *L. barnardi* at a single station in Delaware Bay in 22 m on a sand bottom (Fig. 19). The scarcity of *L. barnardi* in our collections is probably due to its preference for depths shallower than we routinely sampled.

Family LYSIANASSIDAE

Anonyx liljeborgi Boeck 1871

This cold-water species is known to occur from the Canadian subarctic to Delaware between intertidal depths and 200 m on sand bottoms (Bousfield 1973). We collected *A. liljeborgi* at 16 stations between Cape Cod and New Jersey (Fig. 20). Its mean density was low ($20/m^2$), ranging between $2/m^2$ and $80/m^2$. Our collections occurred between 38 and 92 m, but 75% of the records came from between 40 and 70 m. One sample of *A. liljeborgi* occurred on sandy silt, but the other 15 records came from sand bottoms.

Anonyx sarsi Steele and Brunel 1968

This epibenthic scavenger is circumpolar, and it has been reported south to Rhode Island along the eastern coast of North America (Bousfield 1973). *Anonyx sarsi* was a rare species in our collections, occurring at only three stations between Martha's Vineyard and central New Jersey (Fig. 20). Our records extend the known range of *A. sarsi* to central New Jersey. Its density was low at all three stations ($2\text{-}20/m^2$). The three occurrences were between 38 and 65 m on sand bottoms.

Cheirimedon sp. A

A single specimen of this undescribed species was collected from abyssal waters (2,435 m) south of Cape Cod on a clay bottom (Fig. 20).

Hippomedon propinquus G. O. Sars 1895

Geographic Distribution. This species is widely distributed in the boreal North Atlantic (Stephensen 1935). Shoemaker (1930a) recorded *H. propinquus* from numerous locations around Nova Scotia and Newfoundland. Our collections of *H. propinquus* from 24 stations between Cape Cod and Cape Hatteras greatly extend the range of this species along the eastern North American coast (Fig. 20). It occurred in low densities at all stations ranging from $2/m^2$ to $70/m^2$ with a mean of $20/m^2$. It is much more common in the northern portion of the Middle Atlantic Bight being restricted to the shelf edge south of Long Island.

Figure 20.—Geographic distribution of species from the family Lysianassidae in the Middle Atlantic Bight.

Bathymetric Distribution. Shoemaker (1930a) found this species between 30 and 250 m in the Nova Scotia area. In our collections, *H. propinquus* occurred between 15 and 190 m, but it was most common (20/29) and had the highest densities (20-40/m²) between 40 and 80 m (Table 37). The five stations south of Long Island are all >80 m indicating that this cold-water species submerges in the southern portion of its range.

Table 37.—Bathymetric distribution of *Hippomedon propinquus* in samples from Middle Atlantic Bight.

Depth interval (m)	Number of samples	Mean density (No./m²)
10-19	1	2
20-29	0	—
30-39	1	10
40-49	7	20
50-59	2	40
60-69	6	20
70-79	5	20
80-89	4	4
90-99	1	10
100-149	0	—
150-199	2	4

Sediment Relationship. This species was found on a wide variety of sediment types including gravelly sand, shelly sand, shell, silty sand, and silty clay, but was most often found on sand bottoms (21/29) (Table 38).

Table 38.—Sediment associations of *Hippomedon propinquus* in samples from Middle Atlantic Bight.

Sediment type	Number of samples	Mean density (No./m²)
Sand-gravel	1	10
Shell	1	2
Sand-shell	1	2
Sand	21	20
Sand-silt	3	20
Silt-clay	2	10

Hippomedon serratus Holmes 1905

Geographic Distribution. This species has been reported from the Gulf of St. Lawrence to North Carolina (Bousfield 1973). We collected *H. serratus* in 65 samples from 60 stations between Cape Cod and the mouth of Chesapeake Bay (Fig. 20). It is worth noting that this relatively common species occurred in uniformly low densities ranging between 2/m² and 90/m² with a mean of 15/m². *Hippomedon serratus* showed no latitudinal trend in its density, but it became a rare species south of Delaware Bay.

Bathymetric Distribution. Bousfield (1973) gave the depth range of *H. serratus* as 5->75 m. We collected this species between 13 and 89 m, but the highest mean densities (20/m²), and the majority of the samples (49/65) occurred between 30 and 59 m (Table 39). *Hippomedon serratus* showed no clear evidence of southern submergence.

Table 39.—Bathymetric distribution of *Hippomedon serratus* in samples from Middle Atlantic Bight.

Depth interval (m)	Number of samples	Mean density (No./m²)
10-19	1	2
20-29	8	9
30-39	18	20
40-49	22	20
50-59	9	20
60-69	2	6
70-79	3	6
80-89	2	3

Sediment Relationship. According to Bousfield (1973), *H. serratus* is usually found on sand and sandy silt bottoms. In our samples, it showed a strong preference (61/65) for sand bottoms (Table 40).

Table 40.—Sediment associations of *Hippomedon serratus* in samples from Middle Atlantic Bight.

Sediment type	Number of samples	Mean density (No./m²)
Sand-gravel	1	10
Shell	0	—
Sand-shell	2	6
Sand	61	20
Sand-silt	1	10
Silt-clay	0	—

Hippomedon sp. A

An undescribed species of *Hippomedon* was collected at four of our stations along the continental slope east of New Jersey (Fig. 21). These collections came from between 225 and 474 m on sand (2/4) and silty sand (2/4) sediments. The density of *Hippomedon* sp. A was low (2-6/m²) at all four stations.

Hippomedon sp. B

A single specimen of a second undescribed species of *Hippomedon* was collected at an abyssal station (2,925 m) east of Cape May, N.J., on silt-clay sediments (Fig. 21).

Hippomedon sp. C

Two specimens of a third undescribed species of *Hippomedon* were collected from an abyssal station (3,080 m) east of Sandy Hood, N.J., on a silt-clay bottom (Fig. 21).

Lysianopsis alba Holmes 1905

This species is found on shelly sands and in eelgrass roots in protected waters from Cape Cod to the Gulf of Mexico (Bousfield 1973). We collected *L. alba* at a single station in Vineyard Sound on a gravel bottom at 37 m depth (Fig. 21).

Figure 21.—Geographic distribution of species from the family Lysianassidae in the Middle Atlantic Bight.

Orchomene minuta (Krøyer) 1846

Geographic Distribution. This species is widely distributed in the arctic boreal regions of the North Atlantic, and it has been found between Baffin Island and New Jersey off the east coast of North America (Bousfield 1973). *Orchomene minuta* occurred at 33 stations between Cape Cod and New Jersey in our Middle Alantic Bight collections (Fig. 21). Its mean density was 40/m², ranging between 2/m² and 300/m².

Bathymetric Distribution. This species has been recorded from intertidal depths down to 100 m (Bousfield 1973). We collected *O. minuta* between 23 and 85 m with the highest densities (80-90/m²), occurring between 30 and 49 m (Table 41). *Orchomene minuta* showed no evidence of changing its bathymetric distribution with latitude.

Table 41.—Bathymetric distribution of *Orchomene minuta* in samples from Middle Atlantic Bight.

Depth interval (m)	Number of samples	Mean density (No./m²)
20-29	1	10
30-39	6	80
40-49	13	90
50-59	14	20
60-69	6	20
70-79	9	20
80-89	1	2

Sediment Relationship. *Orchomene minuta* is usually found on fine sand or silty sand (Bousfield 1973). In our collections, *O. minuta* was found most commonly on sand (46/50), but also occurred on gravelly sand (2/50) and silty sand (2/50).

Orchomene pectinata G. O. Sars 1895

This species has previously been recorded from the Norwegian coast and the Arctic Basin between 200 and 1,200 m (Stephensen 1935). We collected single specimens of this bathyal species at two stations along the continental slope (Fig. 21). The station south of Cape Cod was located in 440 m on sand, and the station east of Chesapeake Bay was located in 900 m on silty sand.

Psammonyx nobilis (Stimpson) 1853

According to Scott and Croker (1976), this sand burrowing amphipod has been recorded from western Newfoundland to New Jersey. They found this species to be most abundant on protected intertidal sand flats in northern New England. Our collections from six stations between Cape Cod and New Jersey (Fig. 21) occurred between 7 and 60 m on sand (4/6) and shelly sand (2/6) bottoms at low densities (2-20/m²).

Tmetonyx cicada (O. Fabricius) 1780

This epibenthic scavenger is widely distributed in arctic boreal regions and has been collected from intertidal to abyssal depths (Sars 1895; Stephensen 1935; Barnard 1969). Shoemaker (1930a) reported this species off Nova Scotia in 100-400 m. Our collections of *T. cicada* from three stations on the continental slope (440-550 m) south of Cape Cod constitute a southern range extension for this species off eastern North America (Fig. 21). The density of this species was low (2-4/m²) at the three stations. Two of the stations were on a sand bottom, and the other was on a silty sand bottom.

Family OEDICEROTIDAE

Monoculodes edwardsi Holmes 1905

Geographic Distribution. This species is found from the Gulf of St. Lawrence to the Gulf of Mexico (Bousfield 1973). We collected *M. edwardsi* in 29 samples from 23 stations located between Cape Cod and Virginia (Fig. 22). The mean density of this species was low (9/m²), ranging between 2/m² and 30/m². There was no latitudinal trend in the density of this species.

Bathymetric Distribution. According to Bousfield (1973), *M. edwardsi* is found from low intertidal depths to 75 m. We collected this species between 9 and 73 m, but 80% of the samples occurred between 30 and 59 m (Table 42). *Monoculodes edwardsi* showed no change in its bathymetric distribution with latitude.

Table 42.—Bathymetric distribution of *Monoculodes edwardsi* in samples from Middle Atlantic Bight.

Depth interval (m)	Number of samples	Mean density (No./m²)
0-9	1	20
10-19	1	10
20-29	1	4
30-39	6	7
40-49	6	9
50-59	12	10
60-69	1	2
70-79	1	2

Sediment Relationship. Bousfield (1973) found *M. edwardsi* on fine sand and silty sand sediments. In our collections, it occurred on sediments ranging from sandy gravel to silt clay, but 80% of the collections came from sand bottoms (Table 43).

Table 43.—Sediment associations of *Monoculodes edwardsi* in samples from Middle Atlantic Bight.

Sediment type	Number of samples	Mean density (No./m²)
Sand-gravel	1	10
Shell	0	—
Sand-shell	1	20
Sand	23	7
Sand-silt	2	20
Silt-clay	2	20

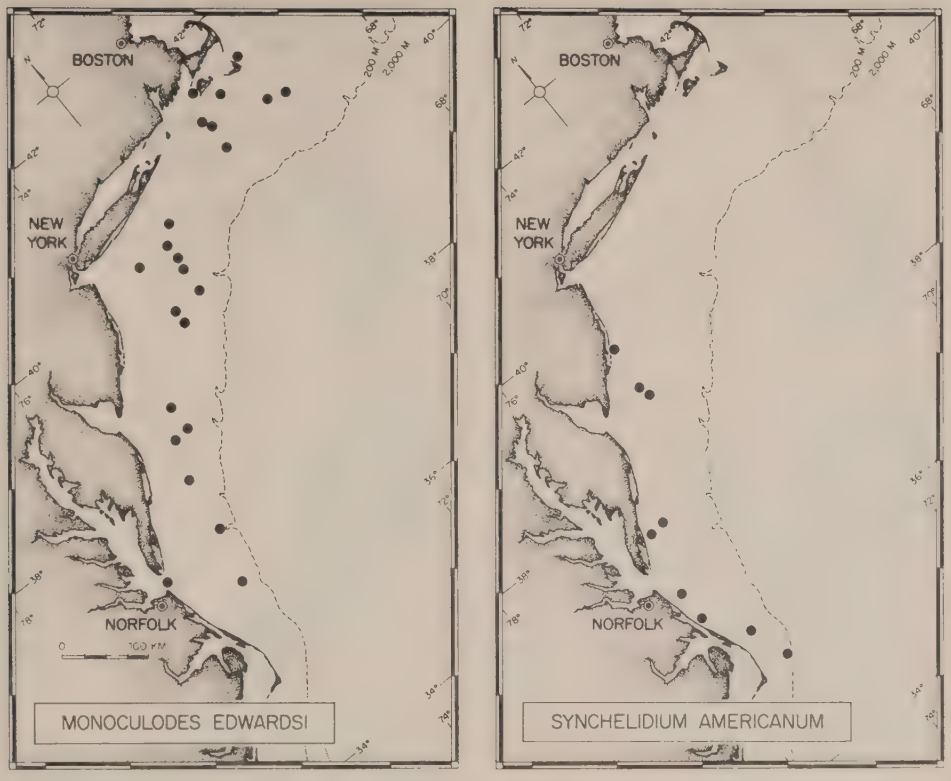

Figure 22.—Geographic distribution of species from the family Oedicerotidae in the Middle Atlantic Bight.

Synchelidium americanum Bousfield 1973

Bousfield (1973) gave the range of this sand burrowing species as Maine to Georgia. He found *S. americanum* on fine sands of semiprotected beaches from just subtidal to a few meters. We collected this species at nine stations between central New Jersey and Cape Hatteras (Fig. 22). *Synchelidium americanum* occurred between 14 and 39 m on sand (6/9) and shelly sand (3/9) sediments, and was rare at all stations (2-9/m²).

Family PHOXOCEPHALIDAE

Harpinia abyssi G. O. Sars 1885

This species has previously been collected in the Norwegian Sea and east and west of Greenland between 400 and 2,700 m (Barnard 1960). *Harpinia abyssi* occurred at a single station east of New Jersey in 2,590 m on a silt bottom (Fig. 23). This record seems to be the first occurrence of this species off the North Atlantic mainland.

Harpinia antennaria Meinert 1893

This species has previously been reported from Norway, Iceland, British Isles, and Greenland (Barnard 1960). In our Middle Atlantic Bight samples, *H. antennaria* occurred in 14 samples from 11 stations distributed along the continental slope between Long Island and Norfolk, Va. (Fig. 23). The density of *H. antennaria* was uniformly low (2-30/m²) at these bathyal stations. The depth range of this species in our collections was 125-1,550 m, but the majority of the samples (9/14) occurred between 300 and 500 m. These collections came from sand (1/14), silty sand (6/14), silt (5/14), and clay (2/14) bottoms. These records constitute a southern range extension for this species along the North American Atlantic coast.

Harpinia propinqua G. O. Sars 1895

Geographic Distribution. This amphi-Atlantic species has previously been recorded as far south as Cape Cod Bay along the east coast of North America (Bousfield 1973). We collected *H. propinqua* in 121 samples from 86 stations between Cape Cod and Cape Hatteras (Fig. 23). These records extend the range of this species to Cape Hatteras. This species has a mean density of 20/m², ranging between 2/m² and 170/m².

Bathymetric Distribution. Harpinia propinqua has been reported between 10 and 1,100 m (Barnard 1960). In our Middle Atlantic Bight samples, it occurred

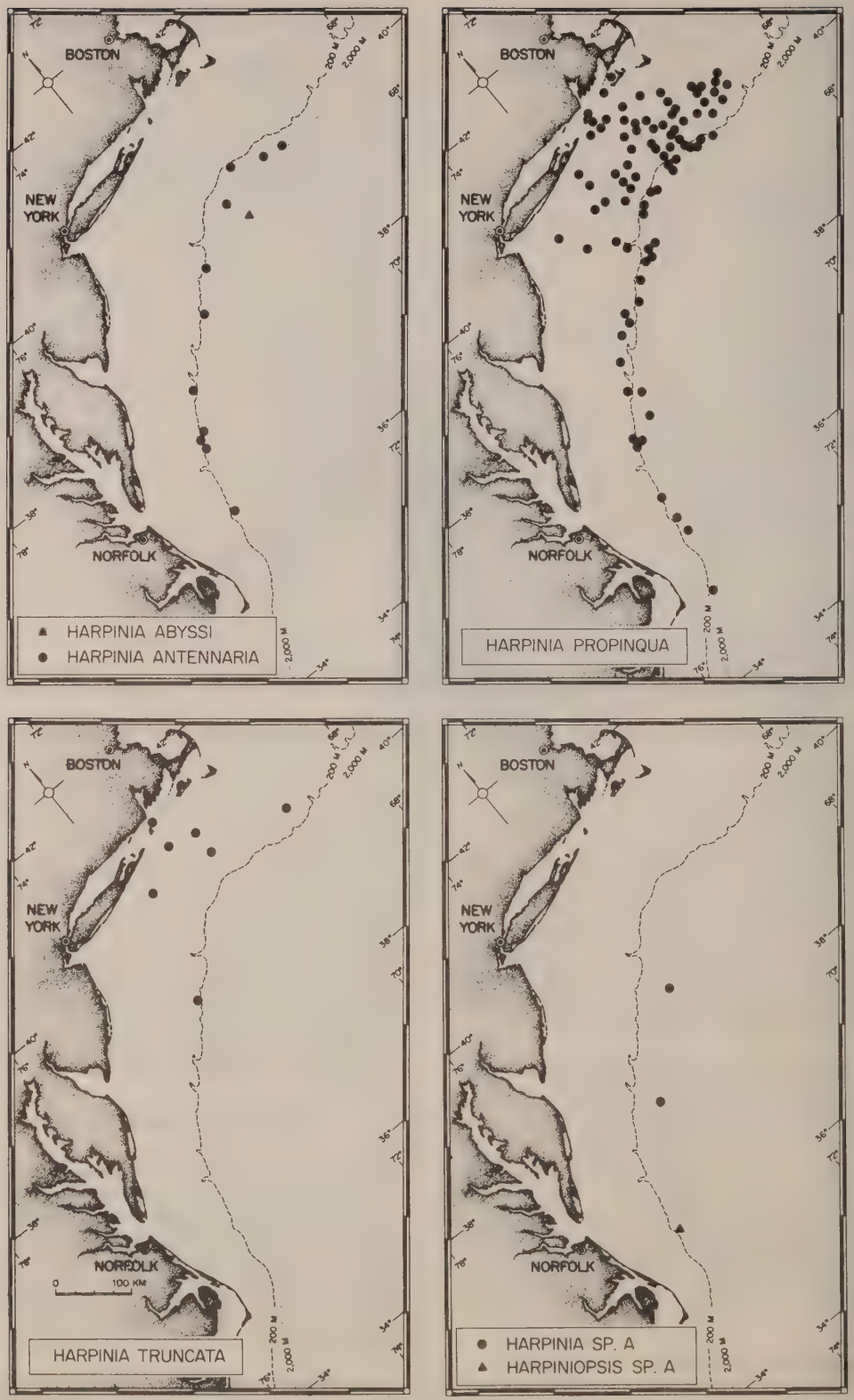

Figure 23.—Geographic distribution of species from the family Phoxocephalidae in the Middle Atlantic Bight.

between 15 and 1,515 m. The density of this eurybathic species showed no strong pattern of change with depth, but it did become scarce (0-4/m²) at depths <30 m and >500 m (Table 44). This species showed a clear pattern of southern submergence since all the records south of New Jersey occurred at depths >80 m (Fig. 23).

Table 44.—Bathymetric distribution of *Harpinia propinqua* in samples from Middle Atlantic Bight.

Depth interval (m)	Number of samples	Mean density (No./m²)
10-19	1	2
20-29	0	—
30-39	3	20
40-49	12	50
50-59	13	50
60-69	7	40
70-79	18	30
80-89	10	10
90-99	17	20
100-124	2	40
125-149	4	10
150-199	3	10
200-299	5	10
300-499	17	10
500-999	8	4
1,000-1,999	1	2

Sediment Relationship. Bousfield (1973) found this species on sand and silty sand sediments. We collected *H. propinqua* on bottoms ranging from shell to silt-clay (Table 45). Although the highest mean density (40/m²) of *H. propinqua* was recorded from sand bottoms, it should be pointed out that more than half of the samples (63/121) were collected from sand-silt and silt-clay bottoms.

Table 45.—Sediment associations of *Harpinia propinqua* in samples from Middle Atlantic Bight.

Sediment type	Number of samples	Mean density (No./m²)
Sand-gravel	0	—
Shell	1	7
Sand-shell	2	8
Sand	55	40
Sand-silt	37	20
Silt-clay	26	10

Harpinia truncata G. O. Sars 1895

This species is known from Iceland, Norway, and the Gulf of St. Lawrence (Barnard 1960; Bousfield 1973). We collected *H. truncata* at seven stations on the continental shelf between Long Island and Cape May (Fig. 23). Its density was low at all stations, ranging between 3/m² and 90/m². The seven stations ranged between 34 and 124 m on sand (5/7), sand-silt (1/7), and silty clay (1/7) sediments. These records constitute a southern range extension for this species along the North American Atlantic coast.

Harpinia sp. A

An undescribed species of *Harpinia* occurred at two deepwater stations off the coast of New Jersey (2,495 m—silt) and Maryland (1,955 m—silt) (Fig. 23).

Harpiniopsis sp. A

A single male specimen of this unidentified species occurred east of Norfolk, Va., at 960 m depth on a silt bottom. (Fig. 23).

Paraphoxus epistomus (Shoemaker) 1938

Geographic Distribution. This species has been reported from both coasts of North America (Barnard 1960). Along the American Atlantic coast, it has been recorded from southern Maine to North Carolina (Bousfield 1973). We collected *P. epistomus* in 191 samples from 181 stations between Cape Cod and Cape Hatteras (Fig. 24). Although this species occurred throughout our study area, it was only moderately abundant with a mean density of 60/m², ranging between 2/m² and 500/m². The mean density of this species was highest in southern New England (94/m²), decreasing in the New York Bight (38/m²) and Chesapeake Bight (53/m²).

Bathymetric Distribution. According to Bousfield (1973), *P. epistomus* has been collected to >50 m. In our samples, it occurred between 7 and 180 m. The density of this species varied little with depth (Table 46), but the majority of the collections (177/191) occurred between 10 and 79 m. The depth distribution of this open shelf species showed no evidence of change with latitude.

Table 46.—Bathymetric distribution of *Paraphoxus epistomus* in samples from Middle Atlantic Bight.

Depth interval (m)	Number of samples	Mean density (No./m²)
0-9	3	60
10-19	15	60
20-29	32	50
30-39	49	70
40-49	32	90
50-59	21	30
60-69	18	50
70-79	10	50
80-89	5	7
90-99	1	60
100-124	2	9
125-149	2	40
150-199	1	10

Sediment Relationship. This species usually occurs on sandy sediments (Bousfield 1973). We found it on sediments ranging from gravelly sand to sand, but over 80% of the samples occurred on sand bottoms (Table 47).

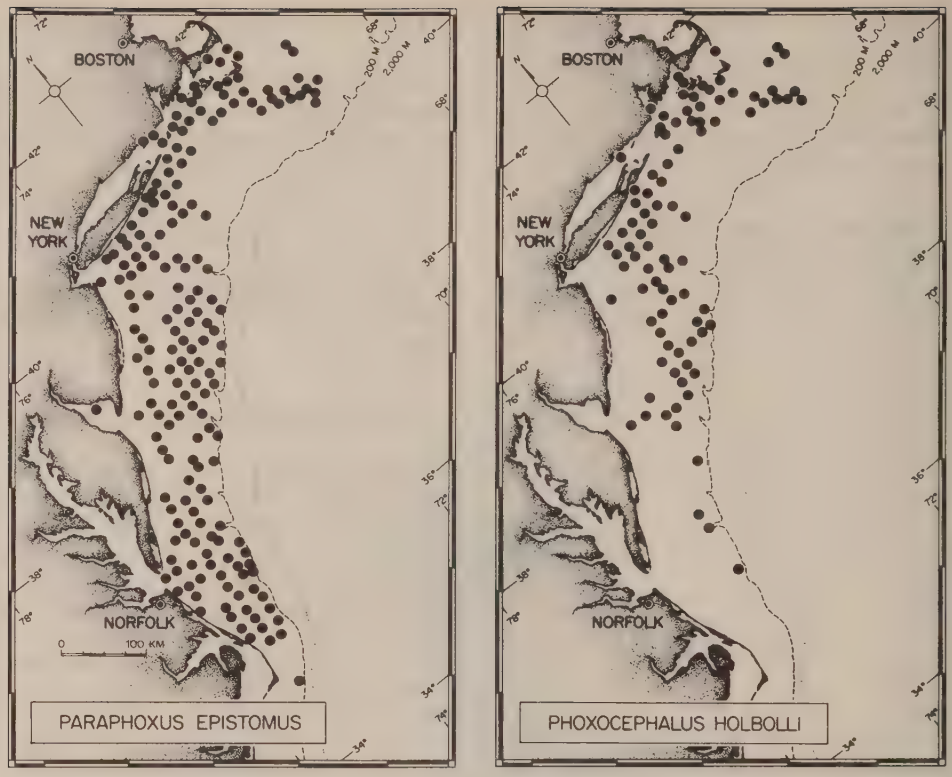

Figure 24.—Geographic distribution of species from the family Phoxocephalidae in the Middle Atlantic Bight.

Table 47.—Sediment associations of *Paraphoxus epistomus* in samples from Middle Atlantic Bight.

Sediment type	Number of samples	Mean density (No./m²)
Sand-gravel	5	40
Shell	7	40
Sand-shell	19	30
Sand	160	60
Sand-silt	0	—
Silt-clay	0	—

Phoxocephalus holbolli (Krøyer) 1842

Geographic Distribution. This species is widely distibuted in the arctic-boreal regions of the North Atlantic (Barnard 1960). Along the eastern coast of North America, it has previously been recorded as far south as Long Island (Bousfield 1973). We collected *P. holbolli* in 108 samples from 90 stations between Cape Cod and the mouth of the Chesapeake (Fig. 24). Our 53 records south of Long Island constitute a southern range extension for this species. The density of this relatively common species was low, ranging between 2/m² and 220/m² with a mean of 30/m². The mean density of this cold-water species decreases from north to south going from 50/m² in southern New England to 9/m² in the New York and Chesapeake Bights.

Bathymetric Distribution. According to Bousfield (1973), *P. holbolli* may be found from the low intertidal to 400 m. It occurred between 13 and 180 m in our samples, but 80% of the occurrences were between 30 and 69 m (Table 48). This species was found in deeper water in the southern part of our study area.

Table 48.—Bathymetric distribution of *Phoxocephalus holbolli* in samples from Middle Atlantic Bight.

Depth interval (m)	Number of samples	Mean density (No./m²)
10-19	4	30
20-29	8	60
30-39	19	40
40-49	29	30
50-59	25	20
60-69	15	20
70-79	5	9
80-89	1	2
90-99	1	2
100-149	0	—
150-199	1	2

Sediment Relationship. This species has previously been recorded on sediments ranging from fine sand to sandy silt (Bousfield 1973). We found *P. holbolli* most commonly on sand bottoms (86/108), but it also occurred on gravelly sand, shelly sand, shell, shelly silt, and sandy silt (Table 49).

Table 49.—Sediment associations of *Phoxocephalus holbolli* in samples from Middle Atlantic Bight.

Sediment type	Number of samples	Mean density (No./m²)
Sand-gravel	10	40
Shell	3	30
Sand-shell	6	20
Sand	86	30
Sand-silt	3	10
Silt-clay	0	—

Family PLEUSTIDAE

Stenopleustes gracilis (Holmes) 1905

This species has been recorded from the south side of Cape Cod to Chesapeake Bay in shallow water on sandy bottoms (Bousfield 1973). In our collections, *S. gracilis* occurred at four stations between 18 and 52 m on sand and shelly sand bottoms (Fig. 25). This species seems to be rare throughout its geographic range.

Stenopleustes inermis Shoemaker 1949

Geographic Distribution. Bousfield (1973) reported that this species occurs from the Bay of Fundy to Cape Cod Bay. Our collections from south of Cape Cod to Cape May constitute a southern range extension for this species off the east coast of North America (Fig. 25). *Stenopleustes inermis* occurred in 25 samples from 20 stations always in low densities (2-40/m²). This species is rare south of Long Island.

Bathymetric Distribution. Bousfield (1973) gave the bathymetric range for this species as 5-50 m. In our collections, *S. inermis* occurred at somewhat greater depths, between 23 and 97 m. It occurred most frequently between 40 and 70 m (Table 50). The discrepancy between the bathymetric range given by Bousfield and that found in our samples may be the result of submergence of this species in the southern part of its geographic range.

Table 50.—Bathymetric distribution of *Stenopleustes inermis* in samples from Middle Atlantic Bight.

Depth interval (m)	Number of samples	Mean density (No./m²)
20-29	1	2
30-39	0	—
40-49	7	20
50-59	6	10
60-69	6	9
70-79	3	20
80-89	1	10
90-99	1	20

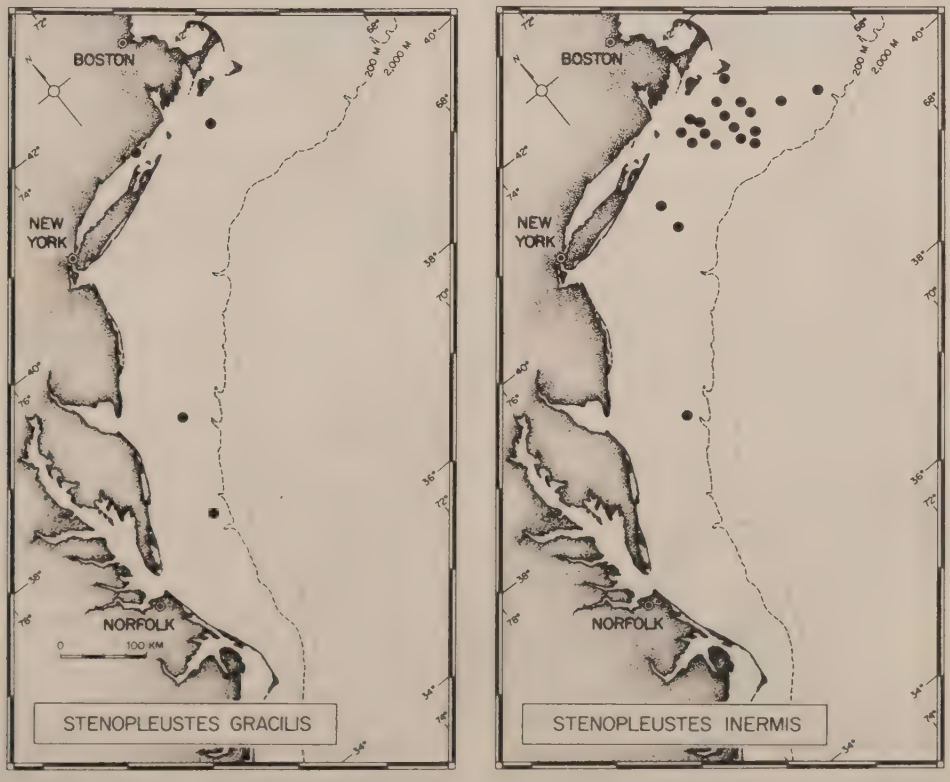

Figure 25.—Geographic distribution of species from the family Pleustidae in the Middle Atlantic Bight.

Sediment Relationship. Bousfield (1973) reported that *S. inermis* is epibenthic on finer sediments. We found this species on sand-gravel (1/25), sand (17/25), silty sand (4/25), and silt-clay (3/25) bottoms.

Family PODOCERIDAE

Dyopedos monacantha (Metzger) 1875

Geographic Distribution. This caprellid-like gammaridean has been recorded across the boreal regions of the North Atlantic and has previously been collected as far south as Cape Cod Bay (Laubitz 1977). Our collections of *D. monacantha* from Cape Cod to Cape Charles extend its range to the south (Fig. 26). This species occurred in 27 samples from 25 stations with a mean density of 30/m², ranging from 2/m² to 290/m². The station with the highest density occurred in Vineyard Sound which is an area of strong currents, which correlates well with the filter-feeding habits of *D. monacantha.*

Bathymetric Distribution. According to Laubitz (1977), this species has been collected between 20 and 320 m. Our records of *D. monacantha* occurred between 18 and 89 m with the highest mean density (80/m²) between 20 and 29 m (Table 51).

Table 51.—Bathymetric distribution of *Dyopedos monacantha* in samples from Middle Atlantic Bight.

Depth interval (m)	Number of samples	Mean density (No./m²)
10-19	1	20
20-29	4	80
30-39	5	40
40-49	4	20
50-59	5	10
60-69	2	30
70-79	4	30
80-89	2	3

Sediment Relationship. According to Enequist (1949), *D. monacantha* is usually found clinging to algae, hydroids, and bryozoans. In our collections, *D. monacantha* occurred on bottom types ranging from sand-gravel to silt-clay (Table 52). The largest numbers of samples (6-16/27) and the highest mean densities (40/m²) occurred on sand-gravel and sand sediments.

Family STENOTHOIDAE

Metopella angusta Shoemaker 1949

According to Bousfield (1973), this cold-water species occurs from the Bay of Fundy to New Jersey on fine sedi-

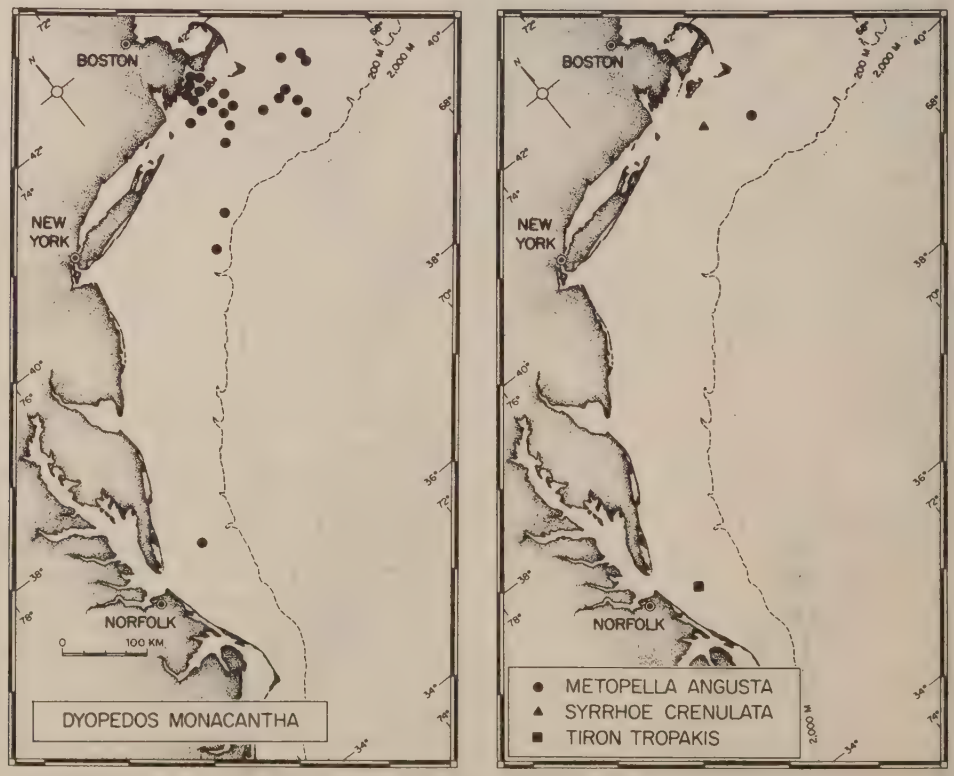

Figure 26.—Geographic distribution of species from the families Podoceridae, Stenothoidae, and Synopiidae in the Middle Atlantic Bight.

Table 52.—Sediment associations of *Dyopedos monacantha* in samples from Middle Atlantic Bight.

Sediment type	Number of samples	Mean density (No./m²)
Sand-gravel	6	40
Shell	0	—
Sand-shell	0	—
Sand	16	40
Sand-silt	4	10
Silt-clay	1	10

ments between 5 and 40 m. In our samples, *M. angusta* occurred at only a single station south of Cape Cod in 62 m on a silty sand bottom (Fig. 26). The scarcity of this species in our collections is most likely a reflection of its small size (3 mm) which may have allowed it to be washed through a 1 mm sieve.

Family SYNOPIIDAE

Syrrhoe crenulata Göes 1866

This widely distributed cold-water species is known from the arctic boreal regions of both the Atlantic and Pacific Oceans between 10 and 300 m (Barnard 1971). According to Bousfield (1973), Cape Cod Bay was the known southern limit for this species off eastern North America. Our collections of *S. crenulata* extend its southern limit slightly since we found it in four grabs from a single station south of Martha's Vineyard in 49 m on a sand bottom (Fig. 26).

Tiron tropakis J. L. Barnard 1972

This warm-temperate species is reported to occur from Virginia to Venezuela in the western Atlantic at depths between 3 and 157 m (Barnard 1972). We collected *T. tropakis* at a single station off the mouth of Chesapeake Bay in 20 m depth on a sand bottom (Fig. 26).

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LITERATURE CITED

BARNARD, J. L.
1960. The amphipod family Phoxocephalidae in the eastern Pacific Ocean, with analyses of other species and notes for a revision of the family. Allan Hancock Pac. Exped. 18:175-375.
1969. The families and genera of marine gammaridean Amphipoda. U.S. Natl. Mus., Bull. 271, 535 p.
1971. Gammaridean Amphipoda from a deep-sea transect off Oregon. Smithson. Contrib. Zool. 61, 86 p.
1972. A review of the family Synopiidae (=Tironidae), mainly distributed in the deep sea (Crustacea: Amphipoda). Smithson. Contrib. Zool. 124, 94 p.
1973. Revision of Corophiidae and related families (Amphipoda). Smithson. Contrib. Zool. 151, 27 p.
BARNARD, J. L., and M. M. DRUMMOND.
1976. Clarification of five genera of Phoxocephalidae (Marine Amphipoda). Proc. Biol. Soc. Wash. 88:515-548.
BOUSFIELD, E. L.
1965. Haustoriidae of New England (Crustacea: Amphipoda). Proc. U.S. Natl. Mus. 117(3512):159-240.
1973. Shallow-water gammaridean Amphipoda of New England. Cornell Univ. Press, Ithaca, N.Y., 313 p.
1977. A new look at the systematics of gammaroidean amphipods of the world. Crustaceana, Suppl. 4:282-316.
BOWMAN, R. E., and R. W. LANGTON.
1978. Fish predation on oil-contaminated prey from the region of the ARGO MERCHANT oil spill. *In* In the Wake of the ARGO MERCHANT, p. 137-141. Univ. Rhode Island, Cent. Ocean Manage. Stud.
BYNUM, K. H., and R. S. FOX.
1977. New and noteworthy amphipod crustaceans from North Carolina, U.S.A. Chesapeake Sci. 18:1-33.
CHEVREUX, É., and L. FAGE.
1925. Amphipodes. [In Fren.] Faune Fr. 9, 488 p.
EKMAN, S.
1953. Zoogeography of the sea. Sidgwick and Jackson Ltd., Lond., 417 p.
ENEQUIST, P.
1949. Studies on the soft-bottom amphipods of the Skagerak. Zool. Bidr. Upps. 28:297-492.
FOX, R. S., and K. H. BYNUM.
1975. The amphipod crustaceans of North Carolina estuarine waters. Chesapeake Sci. 16:223-237.
GURJANOVA, E. F.
1951. Amphipoda-Gammaridea of the seas of the USSR and adjoining waters. [In Russ.] Keys to the Fauna of the USSR. Zool. Inst. Acad. Sci. USSR No. 41, 1031 p.
HESSLER, R. R., and H. L. SANDERS.
1967. Faunal diversity in the deep-sea. Deep-Sea Res. 14:65-78.
HOLMES, S. J.
1905. The Amphipoda of southern New England. Bull. [U.S.] Bur. Fish. 24:459-529.
LAUBITZ, D. R.
1977. A revision of the genera *Dulichia* Krøyer and *Paradulichia* Boeck (Amphipoda, Podoceridae). Can. J. Zool. 55:942-982.
LIE, U.
1968. A quantitative study of benthic infauna in Puget Sound, Washington, USA, in 1963-1964. Fiskeridir. Skr., Ser. Havunders 14:229-556.
MILLS, E. L.
1962. A new species of liljeborgiid amphipod, with notes on its biology. Crustaceana 4:158-162.
1964. *Ampelisca abdita*, a new amphipod crustacean from eastern North America. Can. J. Zool. 42:559-575.
1967a. The biology of an ampeliscid amphipod crustacean sibling species pair. J. Fish. Res. Board Can. 24:305-355.
1967b. A reexamination of some species of *Ampelisca* (Crustacea:

Amphipoda) from the east coast of North America. Can. J. Zool. 45:635-652.

1971. Deep-sea Amphipoda from the western North Atlantic Ocean. The family Ampeliscidae. Limnol. Oceanogr. 16:357-386.

SARS, G. O.

1895. An account of the crustacea of Norway with short descriptions and figures of all the species. Vol. 1. Amphipoda. Alb Cammermeyers Forlag, Copenh., 711 p.

SCOTT, K. J., and R. A. CROKER.

1976. Macroinfauna of northern New England marine sand. III. The ecology of *Psammonyx nobilis* (Stimpson), 1853 (Crustacea: Amphipoda). Can J. Zool. 54:1519-1529.

SHOEMAKER, C. R.

1930a. The lysianassid amphipod crustaceans of Newfoundland, Nova Scotia, and New Brunswick in the United States National Museum. Proc. U.S. Natl. Mus. 77(4):1-19.

1930b. The Amphipoda of the Cheticamp Expedition of 1917. Contrib. Can. Biol. 5:221-316.

1945a. The amphipod genus *Photis* on the east coast of North America. Charleston Mus. Leafl. 22, 17 p.

1945b. The amphipod genus *Unciola* on the east coast of America. Am. Midl. Nat. 34:446-465.

STEELE, D. H., and V. J. STEELE.

1973. Some aspects of the biology of *Calliopius laeviusculus* (Krøyer) (Crustacea, Amphipoda) in the northwestern Atlantic. Can. J. Zool. 51:723-728.

STEPHENSEN, K.

1935. The Amphipoda of N. Norway and Spitzbergen with adjacent waters. Tromsø Mus. Skr. Vol. III, 140 p.

WIGLEY, R. L., and R. B. THEROUX.

In press. Macrobenthic invertebrate fauna of the Middle Atlantic Bight Region. Part II. Faunal composition and qualitative distribution. Geol. Surv. Proj. Pat.

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